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CONTRIBUTIONS:

All Letters and Contributions intended for Publication should be addressed to:—
K. R. DOGGETT, Editor,
"The Dock and Harbour Authority,"
19, Harcourt Street, London, W.1.
Telephone: PADdington 0077/8.

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Editorial Comments

The Port of Colombo.

Originally, and until the year 1870, the Port of Colombo was an open roadstead which only afforded safe anchorage for about four months of the year, and Galle, situated some 80 miles to the south, was the main port of the Island of Ceylon. Although Galle was inconvenient and dangerous of access owing to the rocks and reefs which exist not only within the harbour but also in its approaches, it had served as the main port from the time of the Portuguese and Dutch occupation till 1796, when Colombo was handed over to the British.

The coffee boom in Ceylon, which reached its peak about 1860, was the main incentive to the construction of a safe and sheltered harbour at Colombo, which, by this time, had become the seat of Government for the Island and also the centre of commerce and trade. A further incentive was the opening of the Suez Canal in 1869, which brought about a large increase in the volume of traffic on the trade routes to the Orient and Colombo's convenient situation in relation to this trade rapidly made it one of the most important ports of call in the East.

Proposals to provide increased and better harbour accommodation for Ceylon by developing the harbour at Pointe de Galle were first mooted in 1866 and subsequently transferred to Colombo itself, where the construction of protection works was commenced in 1875, under the direction of Sir John Coode, K.C.M.G. Completed in 1885, they transformed the former open roadstead into a harbour completely sheltered on the most exposed side—the South West. Subsequently, various extensions of the works were made and these, with various other improvements in the harbour, were described in an article which appeared in this Journal in March, 1926.

Since that date, plans for the further development of the port have been under consideration, but owing to the war, they could not be carried into effect. Now large-scale revised plans have been drawn up, and a Report has been submitted to the Ceylon Board of Ministers. Full details of the proposals will be found elsewhere in this issue.

Two recommendations in the Report are of outstanding importance, and, if adopted, their effect will be watched with interest. Hitherto, that is until the outbreak of the recent war, the Chairman of the Harbour Commission was the chief and practically the only executive officer, the Board having no statutory powers and its functions being purely advisory. The circumstances of the war created the necessity for a more effective system of port control and it is now felt that the time has arrived for the formation of a port authority on the lines of other modern harbours in the world and the grouping of all port activities under their direction and governance. The second matter is an affair of internal management. It is felt desirable that a Traffic Department should be created to deal with the handling and warehousing of all cargo from the ship's side. Both these measures would add to the efficiency of the port.

The Development of Indian Ports.

The Report of the Ports Technical Committee, a copy of which has just been received, contains several recommendations which, if adopted, will have a profound influence on the future of a number of ports in the Indian Provinces and Native States.

The Committee was appointed by the Government of India in January, 1946, and a summary of their conclusions will be found elsewhere in this issue. If their recommendations are carried into effect, a great expansion in port capacity in India can be expected within the next few years, and as a consequence, there is likely to be a considerable increase in the Indian coastal shipping trade, as this form of transport should prove more economical than the present practice of carrying goods long distances by rail.

The geographical position of India in the Indian Ocean, and its strategic importance as regards commercial interests in the Far East, make the adoption of a far-sighted policy for the development of port accommodation imperative. At present, the West Coast of India is equipped with only three large deep-sea ports, Karachi, Bombay and Cochin, if we except the Port of Goa which is in Portuguese territory, while the deficiency of ports on the East Coast, felt so seriously during the war, has made the Government consider the advisability of establishing further deep-sea ports on this side of India.

The chief ports on the East Coast are Madras, Vizagapatam and Calcutta. Madras cannot afford security for large ships in cyclonic weather, and at Vizagapatam, the entrance channel limits its availability at present, to vessels of 28-ft. draught. Calcutta, by far the largest port in India, so far as the tonnage of goods handled is concerned, owing to the difficulties of the Hooghly channels, can frequently only accept ships of 26-ft. draught, while only on rare occasions is it possible to receive ships of 30-ft. draught. This is a grave handicap to a port of such importance, and it proved to be a most serious limiting factor during the war.

In order to improve the accommodation and handling facilities at these and several other ports, the Committee has recommended that expensive improvement works, costing some millions of pounds, should be undertaken within the next ten years, and, in addition, the creation of new ports or the development of minor ports in the Indian States is strongly advocated.

Editorial Comments – continued

As stated in the January issue of the *Review* published by the British Export Trade Research Organisation, the latter suggestion seems to be in line with the tendency in recent years for foreign capital to migrate to these territories rather than the provinces, where labour costs and taxation are higher and where economic nationalism is stronger.

Whether all the recommendations contained in the Report are adopted or not, there is no doubt that an extensive development of the ports is inevitable, and India will require from abroad much necessary equipment to carry the plans into effect. Manufacturers of heavy plant and equipment in Great Britain will therefore be well advised to study carefully the position, as there would appear to be encouraging prospects of increasing exports to the Indian market.

Further Decrease in Trade at the Welsh Ports.

The official returns issued early in January by the Great Western Railway Company show that, in 1946, the South Wales ports of Cardiff, Swansea, Newport, Barry, Port Talbot and Penarth, dealt with a total of 11,023,108 tons compared with 12,074,248 tons in 1945, a decrease of 1,051,140 tons in the year. The number of ships that used the ports was reduced from 14,879 to 13,734, a decrease of 1,136.

This continuing decline in trade must cause grave concern to all who are interested in the future of South Wales, and although last year's decrease in tonnage handled can, in the main, be attributed to the cessation of the special war-time traffic, the true significance of the serious state of affairs will be appreciated when it is realised that the total trade of the port in 1938 was 24,528,425 tons. Comparison with this latter figure shows that, in 1945, the ports handled only 51.5% of their 1938 trade and only 47% in 1946.

Although shipments of coal, coke and patent fuel showed a slight increase over the previous year, the total for 1946 was only 5,616,421 tons compared with 19,639,626 tons in 1938. As has been stated in previous comments in these columns, the prosperity of the Welsh ports is contingent mainly upon a revival of the coal export trade, as also the steel and tinplate industries, and any endeavour to divert general cargoes to these ports, can, even if successful, only be a palliative, and has little chance of becoming a permanent solution of the problem.

There is some encouragement in the fact that part, at least, of the regular traffic which perforce had to be discontinued in the war years has been resumed on fairly substantial lines, chief among them being imports of iron ore, iron and steel, and pitwood, which increased from 858,631 tons to 1,458,973 tons and from 139,061 tons to 178,131 tons in the case of the first two items and from 70,018 tons to 261,168 tons in the case of pitwood.

An improvement in the exports of partly manufactured iron and steel goods, tin plates and cement has also been recorded, the figures being from 119,750 tons to 267,095 tons, 36,928 tons to 90,954 tons, and 17,031 tons to 23,566 tons respectively. The returns do not show how much of this increase represented normal commercial business and how much was on account of U.N.R.R.A., but it is to be hoped the improvement indicates that an increased volume of cargo will be dealt with in the years to come.

The North Sea Ports.

In view of the nadir in the fortunes of the Port of Hamburg, which was the subject of comment in the December issue of this Journal, attention has naturally been directed to the prospects of two great rival ports on the adjacent coast of North-Western Europe, viz., Rotterdam and Antwerp. Before the war, this renowned trinity of ports were in keen competition with one another for the seaborne trade of North-Western Germany, Holland, Belgium and Northern France, with Bremen, Amsterdam and Le Havre as "runners-up." Now that Hamburg and Bremen are out of the running and obviously relegated to obscurity for some time to come, it is to be expected that the major Dutch and Belgian ports will derive no little advantage therefrom, modified in some degree by the reduction, temporary of course, in their operating capacity. Of the two, Rotterdam has suffered by far the more in the widespread destruction of its port installations by aerial bombing and military incendiarism. Antwerp was more fortunate in being captured by the Allied forces before the retreating German army had been able to give effect to their "scorched earth" policy in its neighbourhood.

According to recent notices in the press, Rotterdam is making great strides towards rehabilitation, and the restoration of port facilities is outpacing economic recovery. Since the end of the war, energetic measures have been taken in repairing or renewing cranes and other cargo-handling appliances, the storage capacity has been extended, and there has been appreciable progress in the reconstruction of tanks for the storage of both mineral and vegetable oils. That this enterprising attitude is beginning to meet with success, can be seen from the trade returns for the last six months, which show a considerable increase in the number of vessels using the port compared with the corresponding months in 1945.

The hinterland of Rotterdam, extending along the banks of the Rhine, through the great industrial region of Westphalia, is a magnificent asset, since the port can draw therefrom in normal times a huge volume of trade, which, however, it should be admitted consists largely of transhipments, so that the port derives little benefit in the way of local warehousing and attendant services. None the less, Rotterdam, as a cargo-handling port, second only in European waters to London in the extent of its operations, handled something over forty million tons in an average year just before the war. At present, this has fallen to below ten million tons, and in well-informed circles it is considered as not likely to rise very much until there is a settled economic policy for Germany, and, in particular, for the Rhineland.

Antwerp is more closely linked with the industrial interests of Belgium and Northern France; its bulk cargoes have accordingly hitherto been inferior to those of the Dutch port. But it had also an important passenger traffic with North America, rendered noteworthy by the well-known liners, *Belgenland* and *Lapland*. Vessels of the United States Lines have latterly transferred their European terminal from Hamburg to Antwerp, as also to Rotterdam. No doubt these services will continue to expand since the port facilities at Antwerp, at any rate, are in a position to deal with increased traffic.

Altogether, the situation is one of considerable interest and it will be instructive to watch developments at these two North-Western Continental ports during the coming years.

British Port Development Schemes.

Within the past few weeks, details have been given in the press of two ambitious schemes of port development at Hull and Glasgow, involving the aggregate expenditure of some thirteen million pounds. No one, considering the leeway to be made up in consequence of the six years of war and the necessity of providing for the future requirements of sea-borne trade, can regard this sum, impressive as it is, as anything out of the way. Indeed, compared with the cost of some of the schemes of social betterment put forward by the present Government since they came into office, it is in no degree remarkable. Still, the sum is considerable and the schemes they represent should not be embarked upon without the fullest and most careful consideration. We have no doubt that this has been done locally and that the ports in question are convinced of the absolute necessity of the outlay.

But the present moment is a perplexing juncture for heavy expenditure on undertakings which appear to be threatened under the Transport Bill with absorption by the Government for national, instead of local administration. It may be that the Government has other plans in contemplation which may affect the outlook of the ports in question. They may see fit to divert, or re-distribute, maritime services, as has been indicated in recent pronouncements and there may be amalgamations and suppressions of authorities at present functioning in various areas. There is no information, apparently, forthcoming as yet of the Government's intentions, but a note of alarm has already been sounded in the Port of Bristol where fears have been expressed that its dock system estimated to be worth some 11 millions, may be confiscated and handed over to a National Trust with compensation to the local ratepayers of little more than 5 millions.

This should make port authorities pause before incurring any further heavy expenditure for which they will have sole responsibility and no redress in case of expropriation.

The Port of Colombo

Report of Proposals for Further Development

THE following Report, which was placed before a meeting of the Colombo Port Commission by Lt.-Col. P. A. J. Hernu, Chairman, on 29th April last, has been received for publication.

With the cessation of hostilities the question of the development of the Port of Colombo has been taken up once more, but due to certain reasons, various alterations in the original plan have been found necessary.

In 1935 the Oil Dock and Deep Water Quay Scheme was drawn up and although on the outbreak of war the preparation of the drawings and contract terms was far advanced, no further progress could be made until the cessation of hostilities.

The second world war has taught many things. As never before, it was a war of movement on a scale undreamt of before. Vast armies with all their necessary transport, arms and stores had to be moved from one country to another and even across the globe and their lines of communication had to be maintained. Such large scale operations called for a very high degree of organisation of transportation services, with all that it implied in respect of ships, port operating and land transport.

Colombo also shared in this experience of high speed movement of arms and stores in vast quantities and it is as a result of the experience gained, coupled with the fact that improvements in the facilities offered to vessels which call at this port are now long overdue, that a very radical change in the 1935 plan as well as more enterprising and ambitious additions have been found neccessary.

The present disadvantage of Colombo being entirely dependent on the lighterage " link " between ship and shore under existing labour conditions is an added reason for the provision of alongside berths. Long overdue also is a re-organisation of the administration of the port.

The plan of development of the port has been considered under three headings:—(a) Port Construction; (b) Port Administration; (c) Port Operating.

(a) PORT CONSTRUCTION (NEW WORKS)

Colombo, under normal peace-time conditions, is a transit port and as such must offer to ship owners facilities for as short a stay as possible of their ships in the harbour. Deep water berths must be easily accessible, so that no time is lost by vessels after entering the harbour.

It was mainly for this reason that the planning, which commenced in January, 1946, was based on the pier type of development and not the wet-dock type of construction envisaged in 1935 Oil Dock and Deep Water Quay Scheme.

The plan roughly is to segregate the various kinds of operations which normally take place in peace-time in different parts of the harbour and to provide alongside berthage for such operations, without at the same time losing unduly thereby in anchorage berths.

The operations which had to be considered were:—

(1) Oil discharge;
(2) Oil bunkering;
(3) Discharge of railway coal and phosphate cargoes;
(4) Discharge of foodstuffs and general cargo and loading of island products;
(5) Passenger *cum* cargo or purely passenger traffic.

It is now possible to give the broad outline of a definite well-considered scheme for the development of the Port of Colombo, which generally has received the approbation of the Consulting Engineers in London and which should enable the port to compete on equal terms with the other great ports of the East.

Reference to the plan, on the next page, will facilitate following the details of the scheme given below.

(1) Oil Discharge.

A modified and simple dock has been evolved from the 1935 plan. At the same time, the length of the two quays has been increased slightly so that the larger tankers now built can discharge oil in Colombo. Furthermore, provision is made for three loading points for oil barges for the bunkering of ships at anchorage or alongside berths.

The cost will be approximately 12 million rupees and will take about 3 years to complete.

(2) Oil Bunkering.

(a) Two alongside berths will be available for berthing ships at the Guide Pier, the length of which has been increased as the result of the reorientation of the Oil Dock.

(b) Two alongside berths equipped with oil bunkering lines will be available at the proposed North-East Breakwater Quay, if and when not required for the discharge of cargo.

(c) It has also been suggested that oil bunkering lines should be laid on to both the proposed Delft and South-West Breakwater Piers, so that ships requiring oil while loading or discharging cargo need not have recourse to oil barges.

In view of the magnitude of the work involved, this suggestion will have to be examined thoroughly from the financial as well as other points of view.

It may be said that, generally speaking, the Oil Companies have reacted favourably to the suggestion and preliminary discussions have already taken place.

(3) Discharge of Railway Coal and Phosphate Cargoes.

It has been ascertained that the Ceylon Government Railway will have steam traction for the next 15 or 20 years. Consequently adequate arrangements for handling railway coal, as well as the important regular trade in phosphates, merit special consideration in the development of the harbour. It is considered that the conversion of the N.E. Breakwater into a Deep-Water Quay, 1,100 feet long, will provide ideal facilities for these purposes. Furthermore, as this quay can be constructed very much more rapidly than the alongside berths of the Delft Pier, which is another proposal to which reference will be made later, it could be used for the discharge of bagged foodstuffs until the Delft Pier is completed.

As coal and phosphates can be removed immediately by rail, it is proposed to lay three lines of railway track along this quay, with electric quay capstans for shunting the rakes of wagons. The quay will also be sufficiently wide to give ample room for manœuvring lorries removing cargo from foodships. The length of quay, 1,100 feet, will allow of the berthing of two large-sized cargo vessels with a depth of water alongside of 32 feet. Good road access to this quay from the town as well as suitable exchange sidings for railways trucks will be provided.

It is proposed to have suitable warehouses at the back of each of the berths for the storage of cargo, because:

(a) It will be some time before the Delft and S.W. Breakwater Piers are completed and, pending their completion, these two berths will be used for the discharge of food cargoes;

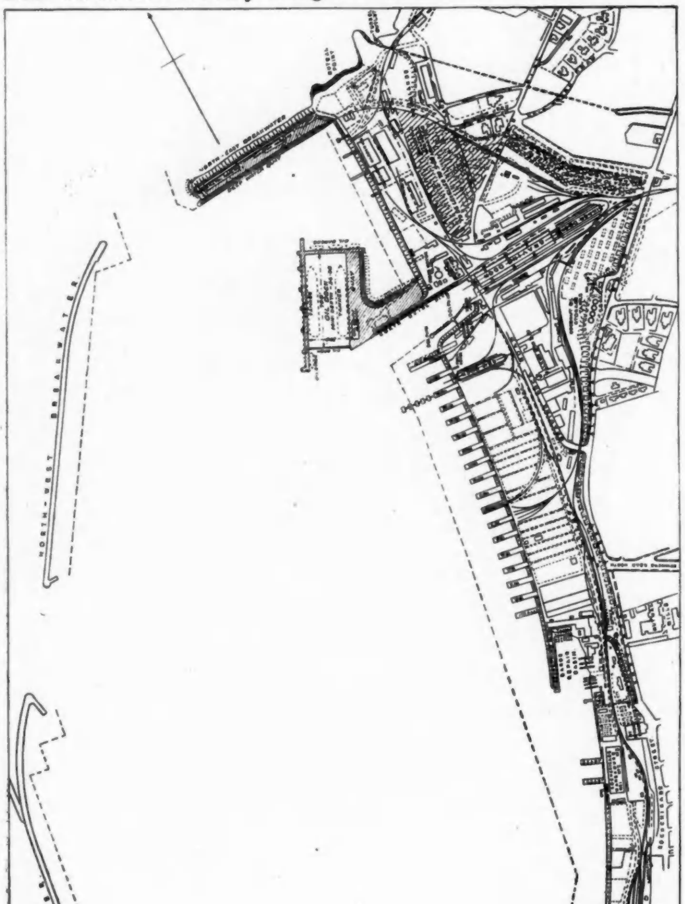
(b) Ships bringing phosphates also carry general cargo, necessitating suitable warehousing space to handle such cargo as well.

Until the Delft Pier is completed, the portal cranes which have been acquired by the Colombo Port Commission will be used on the North-East Breakwater quay. They will be transferred to the Delft Pier after its completion.

It is not considered that the use of one of the berths by two colliers per month would justify the provision of any costly coal-handling plant.

Port of Colombo—continued

The North-East Breakwater Quay will take about 2½ years to complete and cost about 5 million rupees, inclusive of the construction of the warehouses and the acquisition of Fishers Hill, from where the necessary filling for this work will be obtained.



(4) Discharge of Foodstuffs and General Cargo and Loading of Island Produce.

(a) Delft Pier.—It is proposed to build a pier out from the existing quay of the Delft warehouses with its Eastern face running out into the harbour, in approximate prolongation of the Delft bank of the canal to a distance of 1,125 feet, with a depth of 33 feet alongside, so as to provide two excellent berths for large cargo steamers. The Delft warehouses would be demolished and double-storey warehouses (for export and import cargoes) built opposite these alongside berths. The Western quay of this pier would have a length of 1,050 feet and would provide two alongside berths for medium size cargo vessels, or be used as a temporary berth for passenger ships, until the completion of the South-West Breakwater pier, another project which will be referred to later. This quay would also have two-storey warehouses to serve each berth.

The Pier would be provided with rail facilities and would be equipped with portal cranes, fresh-water bunkering points, etc.

The possibility of providing the Southernmost berth of the East Quay (nearest Chalmers Granaries) with mechanical equipment for direct deliveries of bagged grain and flour cargoes over the canal into the granaries is being studied. Everything, however, depends on the Government policy with regard to the importation of basic foodstuffs, i.e., whether Government or private importers will import such foodstuffs in the future.

The estimated cost of this work is 17½ million rupees approximately, inclusive of the construction of the double-storey warehouses. This project will take approximately 3 years to complete.

(b) Delft Coaster Berth.—To meet the requirements of the regular Tuticorin trade, it has been decided to convert the existing temporary alongside berth near the Main Street Bridge into a permanent berth, as it has proved invaluable for handling food cargoes ever since it was first used during the November, 1945, lightermen's strike. It will have a length of quay of 300 feet, with an alongside draft of 18 feet.

The estimated cost of this work is Rs. 80,000 and it will take 5-6 months to complete. Work has already commenced on this project.

(5) Passenger-cum-Cargo or Purely Passenger Traffic.

S.W. Breakwater Pier.—It is proposed that this pier will be built out from the root of the S.W. Breakwater in a north-easterly direction. The North and South Quays of this pier will have respectively 875 feet and 650 feet length of berth and be equipped with Portal cranes and warehouses, and will be rail-served. The Eastern Quay will have a length of 900 feet with 36 feet depth of water alongside.

It is proposed that this pier should accommodate principally cargo-cum-passenger vessels, as well as purely passenger liners. The East Quay will be able to take the largest vessels which have called at Colombo up to the present, and will cater for the new 29,000-ton P. & O. and Orient Liners which are now being built.

A new Customs building, which will face the East side of the pier, will be provided with every amenity for the comfort of passengers and the examination of their baggage.

This pier will be completed in about 3½ years at a cost of about 20 million rupees, inclusive of the new Customs building and warehouses. When the new Customs building is completed, it is planned that the Colombo Port Commission will then take over the existing Passenger Jetty building as its office, leaving its present office for the expansion of the Customs Department.

Summary

To summarise, the number of deep water berths which will be available after completion of all these works will be as follows:—

	No. of Berths
Oil Discharge.—Oil Dock	2
Oil Bunkering.—Guide Pier ... ... (Two berths also available at N.E. Breakwater Quay)	2
Railway Coal & Phosphates.—N.E. Breakwater Quay	2
General Cargo & Foodstuffs & Export Cargo	5
Passenger Traffic	3
	14

Port of Colombo—continued

The construction of the Delft and S.W. Breakwater Piers will cause the loss of:—

Six anchorage berths in the S.W. Monsoon;
Five anchorage berths in the N.E. Monsoon.

The figures shows a net gain to the port of 8-9 additional berths dependent on the Monsoons.

It is proposed to carry out the work of the construction of the N.E. Breakwater Quay and the Delft Coaster Berth departmentally. The remainder of the constructional work mentioned above will be carried out under contract.

Reference is now made to other aspects of improvement which will be carried out in the harbour and which are linked up with the general scheme of post-war development.

(1) New Canal Lock into the Beira Lake.

It will be appreciated that although lighterage will tend to be reduced in the new scheme of things, it will still be necessary to have lighters to serve ships lying at anchorage berths as well as those lying alongside the deep water quays. In the former instance, the necessity of lighters is obvious. In the second, it is hoped that lighters will be used extensively for the export trade, as they could come alongside whilst the ship was discharging its cargo for Colombo at an alongside berth with quay cranes and, when ready, the ship could load export cargo from lighters with its own gear.

With this end in view, it is proposed to build a third and larger lock into the lake, capable of taking 80-ton lighters. The lack of this facility in the past has been, it is thought, one of the causes of the lakeside premises not being put to greater use. The provision of facilities which will enable the largest lighters to enter the lake would also encourage the removal of barge repair yards from the harbour front to the lake, and so release valuable space which could be put to more important uses.

(2) Reconstruction of Fort Lighter Quay and Warehouses.

It will not be possible, nor will it be necessary, to accommodate all ships using the port at alongside berths. Consequently, the use of lighters will continue for many years hence. Furthermore, as a number of lighter-berths will be eliminated by the construction of the Delft Pier, it is proposed to rebuild the jetties opposite the Fort Warehouses, so that extra discharge points for handling cargoes out of lighters can be made available. The number of discharge points will be increased from 6 to 12-14 by this proposal, and they will all be equipped with suitable mechanical appliances. To handle this faster flow of cargo, it will be necessary to reconstruct the Fort Warehouses to a more modern design. This project has been under consideration for some time now, and it is proposed to build a two-storey building with suitable mechanical appliances to serve it. This work will take about two years to complete and will cost approximately 3½ million rupees.

(3) Coal Handling Facilities.

It is now necessary to refer to the very serious question of the coal facilities in Colombo. Prior to the war, Colombo had a great name for rapid bunkering and discharging of colliers. Four colliers could be unloaded at that time with great speed. Due to depleted coal-ground labour force, which before the war was composed mainly of Indian immigrants, the position now is that only two colliers can be discharged at one time. The Chairman of the Port Commission and the Harbour Engineer have been actively engaged for some time now in investigating the whole subject of coal handling equipment, with a view to the early reorganisation of this side of the harbour activities. As soon as the plans are completed, it is proposed to ask the representatives of coal interests to a conference to discuss matters with them.

(b) PORT ADMINISTRATION

From 1869 until 1942, the Port of Colombo was administered by the Principal Collector of Customs under the powers vested in him by the Customs Ordinance of 1869. In 1882, the first official body for the port, known as the Harbour Board, was constituted. It consisted of three official and three unofficial members. In 1913 the Colombo Port Commission was formed. It consisted of official members and unofficial members representing various interests connected with the port and the Principal Collector of the time was automatically the Chairman. In common with the Harbour Board, it had, and still has, no statutory powers but acts in a purely advisory capacity.

Aerial View of the Port of Colombo

In 1942, when the volume of ships calling at the port was so large that action to take the situation in hand was necessary, it was decided that the post of Chairman should be filled by someone with considerable experience of port operating and administration, and that a Port Control organisation under the Chairman should be set up to co-ordinate the efforts of all concerned, in order to deal with the considerable quantity of cargo then flowing through the port.

In order that the Chairman of the Colombo Port Commission should have the necessary statutory powers, suitable legislation was introduced under Defence Regulations. This organisation has continued to function up to now and in this connection it is necessary to refer to a matter on which the Government and, in greater detail, the Minister the Hon. Col. J. L. Kotelawala, the Minister for Communications and Works, have already on many occasions made statements, i.e., the operation and administration of the port when Defence Regulations are rescinded.

It will be obvious to anyone with any knowledge of the operation and administration of a port of the size of Colombo that, with the advent of the Deep Water Quays, it will not be sufficient purely to administer the port as in the past. The port will have to be operated on the same lines as other modern harbours of the world

Port of Colombo—continued

by the formation of some form of Port Authority, which will operate the main harbour facilities as common facilities. With this in mind, it was felt that the framing of a Port Ordinance would be a necessary prelude and would enable the harbour to function with greater efficiency in the interim period. It is proposed that certain powers now vested in the Principal Collector of Customs under the Customs Ordinance be incorporated in the Port Ordinance together with the Ordinances covering the activities of the Master Attendant and the Harbour Engineer, thereby grouping under one authority all the activities of the harbour.

Under the proposed Port Ordinance, control of labour in the sense of complete registration and ensuring that Wages Board Ordinances, etc., are complied with, will also be covered. It is not proposed, however, to continue the strict control which was necessary under war-time conditions, as it is obviously most desirable that normal dealings between employers and employees be resumed.

Space does not permit of amplification in greater detail with regard to this matter, but it is hoped that a definite and authoritative statement will be made in the near future. In the meantime, the broad principles which have been described have been approved by the Minister and his Executive Committee.

(c) PORT OPERATING

As in many other ports, it is proposed that the Colombo Port Commission should have a Traffic Department, which, when alongside berths are available, will handle and warehouse all cargo from ship's side.

The Department will operate all the cargo handling equipment and will be responsible for the efficient and rapid transit of cargo through the harbour premises.

It is unnecessary at this juncture to enter into greater detail on this subject, except to observe that any ideas that may have been formed that lighterage in the harbour will be eliminated should be dispelled. This is an entirely wrong appreciation of the situation. On the contrary, lighterage will continue for many years to come, firstly, because it will be impracticable to add to any considerable extent, under existing conditions, to the number of deep water berths which have been planned. Secondly, export cargo which in peace-time exceeds 600,000 tons will, it is felt, be largely handled in lighters.

PARTICULARS OF PORT ACCOMMODATION

In view of the length of time which has elapsed since the publication of the former article on the Port of Colombo, to which reference has been made elsewhere in this issue, and the necessity of bringing up to date the information contained therein, the following particulars of the port accommodation and facilities are extracted from a recent official publication issued by the Port Commission.

The Harbour Accommodation.

The harbour, which has an area of one square mile, is enclosed on all sides, being bounded on the south and east by land and on the north and west by massive breakwaters. The approach to the harbour is free from navigational dangers. There are two entrances, the Western entrance and the Northern entrance. The Western entrance channel is 630-ft. wide, with a navigable depth of 36-ft. L.W.O.S.T. The Northern entrance channel is 550-ft. wide, with a navigable depth of 30-ft. L.W.O.S.T. Vessels drawing 34-ft. can enter by the Western entrance and vessels drawing 29-ft. can enter by the Northern entrance. The programme of dredging is designed to keep pace with that of the Suez Canal in order to enable any ship which has passed through the Canal to enter Colombo Harbour. At present, of the sheltered area of the harbour, which amounts to 643 acres, 246 acres have been dredged to a depth of 36-ft. and over, 140 acres to a depth varying between 36-ft. and 34-ft., and 106 acres to between 33-ft. and 30-ft. The remaining 151 acres have a depth of less than 30-ft.

	S.W. Monsoon.	N.E. Monsoon.
No. of berths (large) ...	31	37
No. of berths (small) ...	9	10
Oil berths (alongside) ...	3	3

By putting more than one ship in a berth, the following seagoing ships, including trawlers but not harbour tugs, have been berthed during one period of acute emergency in 1945:—

S.W. Monsoon	...	129 ships
N.E. Monsoon	...	121 ships

The Guide Pier and the Delft Quay are now being regularly used for alongside berthing of foodships, in order to benefit by the quicker discharge of cargo resulting therefrom.

The Barge Repairing Basin—Port of Colombo

Passenger Jetty.

The Passenger Jetty is a double-decked structure projecting into the harbour from the Custom House. The upper deck is 301-ft. 6-in. long and the lower deck 342-ft. 6-in. long. A portion of the lower deck is leased to a Motor Launch Company, which regulates the landing and exit of passengers from its launches through a turnstile. The licensed money changer of the port occupies a stall on the upper deck at the foot of the flight of stairs leading to the Custom House.

Warehouse Accommodation.

Extensive warehouse accommodation is available for the increasing volume of goods demanding storage pending shipment or removal from the port premises. There is warehouse accommodation of 8,645,307 cu. ft. and a total floor area of 484,657 sq. ft. for dealing with imports, exports, and transhipment cargo. Most of the warehouses have railway facilities and cranes are available where required.

Transhipment Cargo.

The Port Authorities encourage and afford every facility for the transhipment of cargo. No port dues are levied on cargo

Port of Colombo—continued

transferred direct from ship to ship. No rent or dues are recovered on cargo landed, provided it is re-shipped within three clear days. If, however, re-shipment is delayed, the goods are liable to a single payment of transhipment rent and harbour dues, each at the rate of 50 cents a ton for the period of the first three days, and thereafter to payment of rent at the same rate for each period of 5 days or part thereof. This levy is made to discourage delay, with consequent reduction of the accommodation available to others.

H.M. Customs Passenger Jetty—Port of Colombo

Graving Dock.

The Colombo Graving Dock has been described as one of the finest and safest in Asia. It is situated on the portion of the property known as "Uplands," bordering the harbour, and lies nearly due East and West. A jetty 130-ft. long runs parallel to the centre line on the south side of the entrance and a guide pier 800-ft. long on the north side of the entrance. The first sod for the construction of the dock was cut on March 1st, 1899, by the Governor, Sir West Ridgeway. It was opened for traffic on October 31st, 1906, by Governor Sir Henry Blake. The first vessel to enter the dock was ss. *Monkseaton*, an iron-screw three-masted steamer 325-ft. in length with a draught of 17-ft.

The length of the dock is 717½-ft. on the floor, the width between the main copings 113-ft., and the least width of the floor 63-ft. The depth of the floor below low water at the head of the dock is 33-ft. and at the stern 34-ft. The width between the copings of the entrance is 85-ft. and the depth of the invert of the entrance below low water is 30-ft. The side walls and bottom are built of concrete in mass work faced with gneiss and concrete facing blocks. The foundations for the dock and entrance were carried to rock level everywhere. The dock is closed by means of a ship's caisson.

The rise of tides above L.W.O.S.T. is from 2-ft. to 3-ft. at spring and vessels up to 29-ft. draught can be dealt with.

There is a pumping station at the dock entrance equipped with two main pumps, capable of emptying the dock in under four hours. There are also two sets of single acting lift pumps for drainage purposes and a steam pumping engine and accumulator for maintaining a hydraulic pressure of 700 lb. a square inch for working the penstocks and capstans, together with air compressor salt water pumps and electric generators of current at 220 volts and 110 volts D.C.

Oil Facilities.

The development of the oil trade at Colombo has been one of the outstanding achievements of the port. From a tonnage of 78,000 in 1922, the bunkers lifted at the port have risen to 587,000 tons in 1945, which is the highest for any year since the inception of the oil facilities. This rise is in a large measure due to the efficient and up-to-date facilities provided for the rapid discharge and bunkering of vessels. The installation of these facilities, however, is of recent date. Before 1922, the only oil facility was a bulk oil depot belonging to a single firm on the harbour foreshore, with a small jetty for pumping oil to and from barges in the harbour.

The inadequacy of this facility and the risk of oil storage on the harbour front were realised as early as 1912, when the Harbour Board looked after the administration of the port, and, after the establishment of the Colombo Port Commission in 1913, the question of the removal of the oil storage to a central depot away from the harbour was investigated. The present facilities were inaugurated in February, 1922. All bulk oil importations were handled by the Common Facilities Oil Scheme, operated by the Colombo Port Commission, including:—

(a) A large storage depot, 93 acres in extent, at Kolonnawa, about 4¼ miles from the harbour;
(b) A measuring tanks depot, 19 acres in extent, at Bloemendahl, about ¾ mile from the harbour;
(c) A discharge jetty on the northern side of the Graving Dock Guide Pier;
(d) Two bunkering jetties abutting on the north-east breakwater;
(e) Two 10-in. pipelines for liquid fuel, a 10-in. pipeline for kerosene oil and benzine, and an 8-in. pipeline for automotive diesel oil, together with the necessary steam driven boosting pumps sited at the root of the Graving Dock Guide Pier and transfer pumps at Kolonnawa.

Coconut Oil Bulk Scheme.

The bulk Coconut Oil Storage and Shipping Scheme was completed and officially opened by the Hon. Mr. J. L. Kotalawala, Minister for Communications and Works, on February 4th, 1946, and during the year a total of 16,336 tons of coconut oil was shipped direct from the storage tanks by floating pipeline to 17 vessels.

The installation consists of four storage tanks, each with a capacity of 445 tons, giving a total storage of 1,760 tons. It is proposed to build shortly two more storage tanks each of 500 tons capacity. The total storage capacity will then be 2,760 tons.

Coaling Facilities.

Coal bunkering is carried out from lighters. An area of 25 acres on the Harbour Foreshore is set apart for the storage of coal. This area is composed of two sections, lots with jetties and lots without jetties. Each section is plotted into lots of convenient sizes, and these are leased to the coal companies. The coal is conveyed from ship to shore by means of lighters, of which there is an ample supply, the total number of coal lighters licensed for the year 1938 being 181, with a total tonnage of 4,014. Large supplies of coal can be procured at all times and

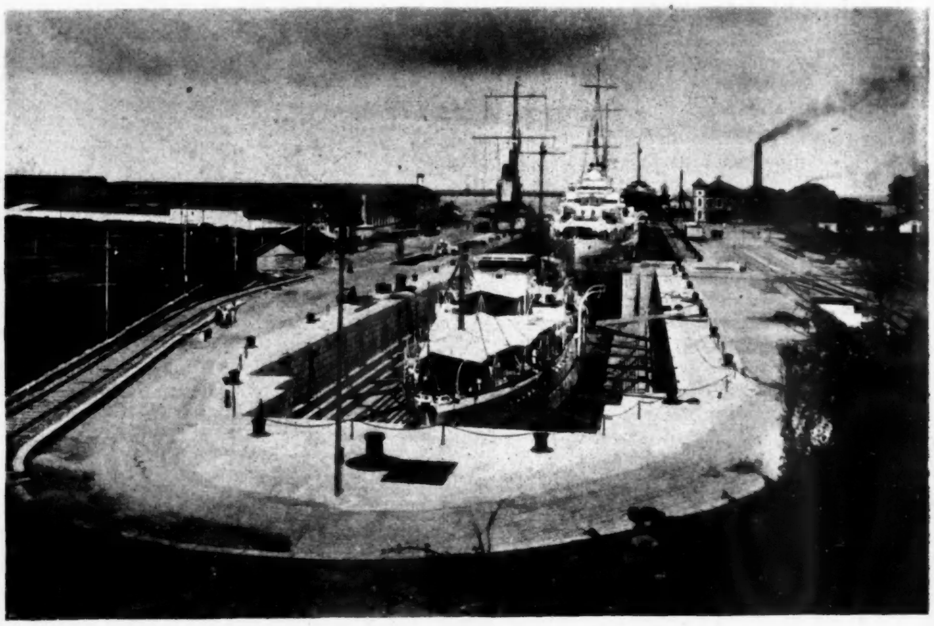
Port of Colombo — continued

steamers are bunkered with despatch at any hour of the day or night.

Port Authority.

The Harbour Board was the first official body to be charged with the administration of the Port of Colombo, and was constituted by Government on October 14th, 1882. It consisted of three official members and three unofficial members, the numbers being increased in 1898 to four official and four unofficial members. The Board functioned till July 1st, 1913, when it was superseded by the Colombo Port Commission, consisting of eight official members and ten unofficial members, representing various commercial, shipping and Ceylonese interests.

The Commission has no statutory functions. It is an advisory body which assists the Chairman in the administration of the Port of Colombo. The Chairman is in charge of all the Ports of Ceylon and is under the general control of the Executive Committe of Communications and Works. The Executive Committee is one of the seven Executive Committees into which the State Council is divided for executive purposes and is charged with the administration of Ports and Harbours, as well as Public Works, Railway, Electrical Undertakings, and Post and Telegraphs.



Inner and Outer Graving Docks—Port of Colombo

Under the Chairman there are three departments: General Administration in charge of the Secretary, and the departments of the Master Attendant and the Harbour Engineer. All these departments and the Joint Magistrate's Court were, in 1932, centralised in one building. This effected considerable economies, established a closer and more effective liaison between all officers, and accelerated the despatch of business.

The finances of the Port of Colombo are similar to those of other Government departments in Ceylon. The revenue is credited to the general revenue of the Island and the expenditure is specifically voted, item by item, by the State Council. Each of its individual votes requires the approval of the Executive Committee of Communications and Works, the concurrence of the Treasury, the approval of the Board of Ministers, the sanction of the State Council, and the ratification of the Governor. The Port Commission is therefore not in control of its own finances.

Trade.

Tonnage of imports and exports, excluding coal and oil, at the Port of Colombo during the last eight years:—

		Imports. Tons.	Exports. Tons.	Total Tons.
1938	...	1,086,949	639,659	1,726,608
1939	...	1,139,802	615,557	1,755,359
1940	...	1,048,343	585,935	1,634,278
1941	...	1,008,556	549,232	1,557,788
1942	...	951,865	601,057	1,552,922
1943	...	1,106,210	709,960	1,816,170
1944	...	1,482,441	606,630	2,089,071
1945	...	1,535,261	615,841	2,151,102

Quantities of coal imported during the last eight years:—

Year.			Tons.
1938	...	...	383,454
1939	...	...	470,304
1940	...	...	500,807
1941	...	...	296,004
1942	...	...	333,479
1943	...	...	218,188
1944	...	...	286,002
1945	...	...	375,924

Imports of oil during the last eight years:—

Year.		Liquid Fuel. Tons.	Kerosene Oil. Tons.	Petrol & Benzine. Tons.	Total Tons.
1938	...	418,991	26,705	34,777	480,473
1939	...	386,159	29,213	41,006	456,378
1940	...	424,151	26,375	37,092	487,618
1941	...	276,778	29,491	41,287	347,556
1942	...	192,041	38,483	61,594	292,118
1943	...	356,539	33,417	27,738	417,694
1944	...	543,742	33,062	28,892	605,696
1945	...	706,862	38,785	77,682	822,729

Officials.

The Chairman of the Commission is Lt.-Col. P. A. J. Hernu; the Master Attendant, Com. D. C. G. Neish, R.N.; the Harbour Engineer, Mr. T. A. Owles, C.B.E., M.Inst.C.E.; and the Secretary, Mr. A. Van Langenberg.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Sir,—

I have received enquiries for some months past from a number of officers and other ranks who served in R.E. (Transportation) units in the pre-war Supplementary Reserve, or in other such units formed during the late war, as to what plans are under consideration for raising R.E. (Transportation) units again in the Post-War Territorial Army. Recent announcements in the Press of the arrangements which have been formulated for the general reconstitution of the Territorial Army have stimulated interest in this subject.

I am directed to inform you that plans are under active consideration to form a number of R.E. (Transportation) units as early as possible. It is hoped that the recruitment of volunteers for service in these units will begin within the next few months.

Yours faithfully,
BRIG. R. F. O'D GAGE, C.B.E., M.C.,
Director of Transportation.

Transportation Directorate,
War Office.
January, 1947.

Port Operation

Part 2 (A) of a series of articles by A. H. J. BOWN, M.Inst.T., A.C.I.S.
and Lt.-Col. C. A. DOVE, M.B.E., M.Inst.T.

Organisation

THE primary purpose of a port in any part of the world is to provide terminal facilities and services for shipping. The term "terminal facilities and services" may embrace many functions, the number depending mainly on the geographical position of the port, its size and importance, and the type of trade for which it caters.

The number of independently operated organisations involved in executing these functions may vary from surprisingly few, as in the case of Manchester, to many, as in the cases of Liverpool or Leith. Among the organisations likely to be found in any port may be listed Port Commissioners, Pilotage Authorities, River Conservancy, Wharfingers, Shipping Companies, Shipping Agents, Shipping Brokers, Forwarding Agents, Ship Builders, Ship Repairers, Lighterage Companies, Towage Firms, Cartage Firms, Railway Companies, Power Companies, Bunkering Firms, Master Stevedores, Labour Contractors, National Dock Labour Corporation, Trade Unions and Customs Authorities.

The actual number of organisations in existence in any one port is not determined as might be expected by the range of functions performed, but very largely as a result of custom which has grown out of expediency or through evolution. It also depends to a large extent on the powers vested in and exercised by the statutory body known variously in different parts of the world as Harbour Board, Port Commissioners, Trustees, Port Authority, Administration, etc., whose primary, though rarely sole, responsibility it is to provide and maintain essential static facilities. Because of this primary responsibility and the statutory right frequently enjoyed by port authorities of exercising wider powers, the type of control or ownership under which a port administration operates has an important influence on the internal organisation of a port, and needs to be examined and understood before a study of port organisation can be undertaken.

At this stage the student might rightly argue that we are trespassing on the sphere of "Port Economics," but, as was stated at the outset, "Port Economics" and "Port Operating" frequently overlap. In all fields of transport, occasions such as this arise when operation must be considered in its economic setting if the *raison d'etre* is to be thoroughly understood. In other words, this is an instance where it is necessary to know "why" as well as "how."

Examination has shown that no two ports are administered on identical lines. There is no standard organisation, although for the purpose of comparison, port undertakings may, at present, be classified into the following five groups:—

(1) Self governing. (Autonomous or Trust.)
(2) Railway owned.
(3) Municipally owned.
(4) Privately owned. (Including Companies.)
(5) State owned.

Important changes are likely in the near future, but these will only become apparent when, as seems probable, the Transport Bill at present before Parliament finally becomes law.

Before proceeding to a brief study of these groups, the student must be warned that it is not unusual for more than one type of undertaking to operate within the same geographical area known as the port. On the Thames, for example, privately owned riverside wharves, capable of berthing sea-going vessels, operate within the area administered by the Port of London Authority, who are not only the statutory body for the Port of London, but also operate dock systems of their own. An even better illustration is afforded by the situation which existed in London prior to the formation of the Port Authority in 1909, when three large privately owned dock companies, as well as the riverside wharves, operated simultaneously with the Thames Conservancy, who at that time were responsible, among other things, for maintaining the approach channel from the sea. A comparable set-up still exists on the Tees, where the London and North Eastern Railway Company operates a dock in Middlesbrough and the River Tees Conservancy maintain the approach channel as conservators of the river. It is interesting to note that as recently as last year the Conservators acquired statutory powers to operate as a dock authority, a power they did not previously possess.

Self-Governing Ports

A self-governing or trust port is one controlled and operated under the direction of the users of the port and other interested organisations, including local public authorities and state departments, all of whom are represented on a governing body usually called a Board.

The following are examples of self-governing port authorities: Port of London Authority, Mersey Docks and Harbour Board (Liverpool); Belfast Harbour Commissioners; River Wear Commissioners (Sunderland), Leith Dock Commission, Clyde Navigation Trust (Glasgow), Calcutta Port Commission and Rangoon Port Commission.

In this country the constitution of the Board, i.e., the number of members and the bodies they represent, is laid down in the Act of Parliament creating the undertaking.

The Board is almost invariably made up of two sorts of members: (1) Elected members; (2) Appointed members, also known as Nominated, presided over by a chairman.

Elected members are those chosen by the users of the port, i.e., Shippers, Importers, Shipping Companies, etc., to represent them. The method generally employed is for each user of the port to be given voting powers in accordance with the amount spent by him on charges levied by the port undertaking over a specified period, and to ballot for a candidate under arrangements made by the port authority in accordance with their statutory powers.

Appointed members are those chosen by the bodies listed in the creating act as having an interest in the working or existence of the port, i.e., Government Departments, usually the Ministry of Transport and the Admiralty; Local Authorities; Pilotage Authorities, etc. In these cases, there is no stipulation in the Act as to the method of ballot, and such bodies nominate their representatives under their own arrangements. The reason for this difference of method in selecting members is not far to seek, for such organisations by their very nature have their own machinery for choosing representatives without putting the port undertaking to the necessity of holding a ballot.

Self-governing port undertakings are ordinarily financed by public subscriptions bearing fixed rates of interest, e.g., short term loans (Leith), stock (London), mortgages (Sunderland). It is interesting to note that in the majority of British ports investors have no direct representation on the Board and therefore no say in the control or management of the undertaking. A notable exception is provided by the River Wear Commissioners (Sunderland), where they are represented on the Board by elected members.

The size of Boards varies from port to port, being as high as 42 in the case of the Clyde Navigation Trust and as low as 15 at Leith. The interests represented vary widely, as the following examples show:—

Port Operation—continued

Port of London Authority

Chairman	1	Appointed by Board, but need not be members.
Vice-Chairman	1	
Appointed		
Admiralty	1	
Ministry of Transport	2*	
London County Council ...	4*	(2 Being Members of the Council and 2 not being members of the Council).
City of London Corporation ...	2	(1 Being a member of the Corporation and 1 not being a member of the Corporation).
Trinity House	1	
Elected		
Payers of rates† Wharfingers and owners of river craft	17	
Wharfingers	1	
	28	(Excluding Chairman and Vice-Chairman).

* 1 member to represent labour after consultation with labour interests.
† Payers of rates on (1) "Vessels other than River Craft" and (2) "Goods."

Rangoon (Prior to 1939).

Appointed	
Governor of Burma ...	1*
Government	6
Elected	
Chambers of Commerce ...	9
Municipality	1
	17

*Chairman.

River Wear Commissioners

Appointed	
Minister of Transport ...	1
Sunderland Corporation ...	14
Elected	
Coalowners ...	5
Shipowners ...	3
Shipbuilders ...	3
Importers and Exporters ...	2
Engine Builders ...	1
Holders of the First Mortgages ...	1
Holders of the Funded Debt ...	1
Holders of the Second Mortgages and Second Mortgage Funded Debt	2
Co-opted by the Appointed and Elected members ...	4
	37

Leith

Elected	
Corporation of Edinburgh* ...	3
Edinburgh Merchant Coy.* ...	1
Edinburgh Chamber of Commerce* ...	1
Leith Chamber of Commerce* ...	1
Shipowners ...	3
Ratepayers ...	6
	15

*Technically all the Commissioners are elected but in practise those marked with an asterisk are appointed.

The work of the Board is usually spread out over various standing committees, who refer the results of their work back to the Board. As will be seen from the illustrations below, they derive their names from the functions they fulfil.

At this stage it is pertinent to draw attention to very interesting and far-reaching differences in the field of selection and the functions of Chairmen in the U.K. and in certain ports under British influence in the Orient. In this country the Chairman is normally chosen by the Board from the shipping or trading communities connected with or having an interest in the port, or, as is sometimes the case, from men well known in public life. The Chairman is concerned with policy and is in no sense an executive, the functions of Chief Executive being normally fulfilled by the General Manager.

In the east, however, the Chairman is not infrequently selected from the staff of the undertaking, as is at present the case at Calcutta and Rangoon, or from the ranks of the permanent civil service, as at Bombay. The difference does not end there, for in addition to carrying out the duties of Chairman, as practised in this country, he also acts as Chief Executive. In effect, he combines the roles of Chairman and General Manager, thus being concerned not only with what is to be done, but how it is to be done.

Summing up, it may be said that Self-Governing Port Authorities owe their growing popularity in many parts of the world to: (1) their power to shoulder the heavy financial burden which the provision and maintenance of ports and docks entails; (2) the representation which they offer to those using the port in the course of business and organisations whose interests are affected, often vitally, by its efficiency and success; (3) their freedom from political considerations; (4) their neutral policy in relation to all forms of transport wishing to use the port.

Municipally Owned Ports

The ownership of docks and ports of any size by towns and municipalities is not widely practised in this country, although it has found considerable favour on the continent of Europe, notably in the Low Countries and Scandinavia.

Bristol and Preston are the best known of our municipal ports. Bristol, by far the largest and most important in the U.K., is controlled and managed for the Municipality by the Docks Committee of the Corporation of Bristol, which is known as "The Port of Bristol Authority." This Committee is drawn entirely from members of the Corporation, who have been elected to the Council by the citizens of the town and who, therefore, rely on their periodical re-election at the Municipal elections to continue their membership of the Docks Committee. It is obvious, of course, that since such elections are largely political, none of the Docks Committee might have any direct interest in, or experience of, matters relating to ports. Against this must be set the very real interest that any member of the City Corporation is certain to have in an undertaking which is bound to affect the prosperity and welfare of the town in which the port is situated, particularly as any loss on working may become a charge against the town.

The characteristics of municipal port undertakings are their (1) great financial resources; (2) ability, if necessary, to offset losses

LONDON
Board

General Purposes Committee | Dock & Warehouse Committee | River Committee | Finance Committee | Staff Committee | Maintenance Committee | Stores Committee | Law and Parliamentary Committee

RANGOON (Prior to 1939)
Board

Work Committee | Finance Committee

RIVER WEAR COMMISSIONERS (Sunderland)
Board

General Purposes and Finance Committee | Works Committee | Traffic Committee | *Corporation Quay and Commerce Committee | Accounts Committee

*Corporation Quay is owned by the Sunderland Corporation but managed on their behalf by the Commissioners.

Port Operation—*continued*

against "invisible assets," such as employment for the townspeople, etc; (3) neutral policy in relation to all forms of transport.

Railway Ownership

Railway companies own and manage many important docks in this country, including those at Hull (L.N.E.R.), Southampton (S. Rly.), Swansea, Cardiff, Newport (G.W.R.), Grangemouth (L.M.S.). It is interesting to note that in the great ports of Hull and Southampton, the Railway companies are not the conservators of the approach channels, these powers being vested in The Humber Conservancy Board and The Southampton Harbour Board respectively.

Railway ownership has been brought about in many cases by the practice often followed by railway companies in the past of acquiring or building docks for the purpose of feeding their railway systems or for use as terminals. These points are well illustrated by a reference to the geographical position of the South Wales ports, now the property of the Great Western Railway Co., but previously owned by separate railway companies, each of which operated a railway serving one coal producing valley, for which the dock offered an outlet to the sea.

Such docks were not necessarily regarded as independent profit earning units, but as ancillary services contributing as part of the service offered by the Railway Companies to the trading or travelling communities. It is now an almost invariable characteristic of railway owned docks in this country, particularly since the amalgamation of the railways in 1921 into four large companies, that they each serve one railway only.

Railway Companies, more especially since the amalgamation, have been enabled by their great financial resources to spend large sums in developing and improving docks, Southampton being an outstanding example.

The characteristics of railway-owned dock undertakings include their (1) great financial resources; (2) ability to offset losses on docks, when incurred, against profits earned over the whole railway system; (3) freedom from political considerations.

Privately Owned Ports

Privately owned ports are those owned and managed for the purpose of making a profit, in the same manner as any other private enterprise. They are normally owned by companies or private individuals operating under statutory powers conferred on them by Parliament.

Originally, many ports were run as private enterprises, but the heavy cost of capitalising them, the rapid obsolescence of expensive facilities caused by the great advance in the size of ships, and the freezing of capital consequent upon the necessity for endeavouring to anticipate such developments, made them unsuitable subjects for this type of undertaking and they gradually came under the control of one or other of the financially more powerful types of organisation. Some of them still remain. One such is Granton, a small port near Edinburgh, built in 1837 by the Duke of Buccleuch from his private fortune, which remained the property of succeeding dukes until 1932, when it was transferred to Granton Harbour, Ltd., of which company the present duke is chairman and other members of the Buccleuch family, directors.

It is a matter of some interest that during a period when the ownership of ports was passing from the hands of private ownership, that it should be left to private enterprise—afterwards backed by strong municipal support—to embark on one of the most courageous, important and successful port developments of modern times. This involved nothing less than the building of a ship canal linking Manchester with the sea and constructing a great inland port at Manchester.

The Port of Manchester is owned and operated by The Manchester Ship Canal Company under powers embodied in The Manchester Ship Canal Act, 1885. The Company is controlled by a Board of 21 directors, of which the shareholders elect ten and the Corporation of Manchester appoints eleven. The Chairman is elected by the Shareholders' Directors, while the Deputy Chairman is elected by the Corporation Directors from amongst their number. The Corporation Directors automatically retire at the end of their period of office with the Council, but they become eligible for re-appointment to the Board if they are re-elected to the Council.

The reason for the presence of Council members on the Board arises from the fact that The Manchester Ship Canal probably owed its completion to the strong financial support given to the Company by the people of Manchester during the time it was under construction, when unexpected and costly difficulties were encountered.

It is often said that the ownership of docks by The Manchester Ship Canal Company is analogous to the railway system of ownership in this country, but the student should note that apart from the representation enjoyed by the municipality on the Canal Company's Board of Directors, which has no counterpart in railway management, one fundamental difference of principle also separates them, i.e., railway owned docks are in the main ancillary to the railway system, but at Manchester the Ship Canal is ancillary to the docks.

A characteristic of Manchester which has already been mentioned is the limited number of organisations within the port. Within its boundary limits, apart from ship building and ship repairing activities, the Company sets itself up as the sole employer of labour and the sole operator of all the many functions (excluding, of course, those exercised by Government departments, such as Customs) necessary to port working, which in most other ports are the work of many independently owned and operated concerns. Such a policy is, in general, foreign to port management and operation in this country at present. Its existence at Manchester may be attributed to the fact that Manchester is essentially a private enterprise.

Despite its undoubted ultimate success, the financial history of Manchester as a port from the time work started until it was opened to traffic, is one fraught with anxiety, and the ever present possibility of failure, which, indeed, was probably only beaten off in the end with the financial aid given by the people of Manchester through the City Corporation. The early difficulties at Manchester lead to the conclusion that large scale port undertakings are not generally suitable for promotion by private enterprise. For this reason alone, it is highly improbable that such an effort will ever again be repeated by private enterprise in this country.

The characteristics of privately owned ports are their (1) relative freedom from restrictions; (2) freedom from political considerations; (3) neutral policy in relation to all forms of transport.

State Owned Ports

Apart from Naval Dockyards, which are outside the scope of our subject, and Military Ports, built during the war for the handling of services cargoes, there are no state owned ports in this country, with the exception of Holyhead Harbour.

They are to be found in various forms on the Continent of Europe and in other countries, including the Union of South Africa, the Condominium of the Sudan, and her close neighbour Egypt.

In both South Africa and the Sudan, ports are the responsibility of the same Government Department as the railways, which are also nationalised, but in Egypt two separate departments exist, ports coming under the Ports and Lights Administration and railways under the Egyptian State Railways.

This difference in systems between Egypt and the Sudan is carried still further. In Alexandria, for example, the Administration does not control transit sheds or warehouses in the dock area. These come under the jurisdiction of private Warehouse Companies or the Egyptian Customs; the Ports and Lights Administration, in fact, only provides facilities to quay level. In Port Sudan, however, all the facilities within the boundary of the docks are provided by the Sudan Railways, who also operate them.

It should be noted by the student that state ownership in its present form is not accompanied by any reduction in the number of organisations operating within the port. In fact, the State rarely seeks to do more than provide a port, leaving the users to work it. On this point it is worthy of comment that the Port Authority which has placed the greatest limitation on the number

Port Operation—*continued*

of organisations operating within the port (though let it be noted not the number of functions, which remain unaffected) is the privately owned authority of Manchester.

The characteristics of State-owned Ports are their (1) enormous financial resources; (2) opportunity of planning on a national basis; (3) neutral attitude to all methods of transport desirous of using the ports.

Internal Organisation

The functions carried out in a port may be classified roughly, according to where they are performed, into two groups:—

(1) Inboard—within the ship.
(2) Outboard—beyond the side of the ship.

The ship's rail is regarded as the boundary.

Inboard

The most important functions included under this head are connected with bunkering, watering, victualling, repairing, loading, discharging, embarking and disembarking. They are normally the responsibility of the "Ship." By "Ship" is meant the Owners or Charterers or their Representatives, known as Ships Agents or Ships Brokers. Where the ship is let, or, to use shipping parlance, chartered, these responsibilities may even be shared by the owners and the charterers, depending upon the terms of the "charter party," which is the contract or agreement between the ship owner and the charterer. Whatever the division of functions between organisations, the operators employed to discharge them are approximately the same.

The normal practice in peace time is for the master of a vessel to report, as soon as possible after arrival in port, to the office of the owner, agent or broker, with his requirements for bunkering, fresh water, stores, repairs, etc., at which time he is in turn advised of his next cargo, given his sailing orders and other instructions, or, as he would say, he "gets his orders from the office."

Arrangements are then made for bunkers to be provided. Large companies may have their own bunkering arrangements, but more usually this is done through a bunkering firm. Stores are obtained from a ships chandler and fresh water is ordered from or through the Port Authority. Repairs and cargo matters are referred to specialists, known as Marine and Cargo Superintendents respectively.

Some firms employ Marine and Cargo Superintendents on their staffs, others let the work out to contract. There is no hard and fast rule, except that in some form or other these operators are almost universally employed.

In former times their duties were the responsibility of the ship's master, but the complexities and demands of modern business ashore make it almost imperative that this work should be delegated to operators familiar with the local shore organisations, who are themselves often ex-Merchant Navy officers.

Their relative responsibilities are best explained by saying that, while the ship is in a port, the Cargo Superintendent covers all matters relating to cargo, the balance being dealt with by the Marine Superintendent.

Among the Marine Superintendent's wide range of responsibilities, the necessity for arranging repairs and overhauls is important. If dry-docking is required, he makes arrangements for the use of the dry dock. Sometimes ship owners have their own ship repairing organisation, but, more usually, repairs are let out to firms specialising in this form of work.

It is the responsibility of the Cargo Superintendent's Department to (1) see that all booked or manifested cargo is loaded or landed; (2) note its condition on receipt or outturn; (3) comply with the requirements of the Master in the matter of stowage; (4) ensure that the stevedore's responsibilities are satisfactorily discharged. The actual job of stowing or discharging the cargo, i.e., the physical handling, is carried out by stevedores, who work in gangs, normally one gang per hook. They may be part of the Cargo Superintendent's organisation, or they may be employees of contractors employed by him, or in some ports they may be employees of the port authority acting in the place of stevedore contractors.

To avoid confusion, mention should be made here of the various uses of the word "stevedore" in this country. In Scotland and the north of England, a "Stevedore" is an employer of men known as "Dockers," who load and discharge ships. In other parts of the U.K., such an employer is known as a "Master Stevedore"—the "Stevedore" being the man who actually works in the hold—the term "Docker" being confined to quay workers. Still another variation is to be found where only men employed on loading in the holds are known as "Stevedores," all others being described as "Dockers." In Liverpool, where the Port Authority do very little operating themselves, "Master Stevedores" load ships, "Master Lumpers" discharge them, and "Master Porters" execute the shore work.

On board the ship, the Cargo Superintendent employs a "Ship's Clerk," whose duties, whether the ship is discharging or loading, include the employment and supervision of checkers (or tally-clerks), who usually work one to each gang.

In addition, his responsibilities cover, when the ship is discharging: (a) acting as the liaison between the chief officer (as representative of the master) and the stevedore foreman, the consignees' representatives and the cargo surveyors; (b) ensuring that the "craft alongside" or "cargo" book is kept up to date; (c) keeping his tally clerks or checkers informed well in advance of rising parcels, and supplying them with the appropriate tally cards already "cut-out," i.e., with all the necessary main details entered, so that the tally clerk can carry on with his tally immediately a tally card is completed, without holding up the work of the gangs whilst he prepares a fresh card; (d) noting and entering all shortages, damage to cargo, etc.; (e) issuing passes for deliveries of complete Bills of Lading or parts of Bills of Lading (in large concerns this is invariably carried out by the Docks Office Inward Freight Department of the shipping company, in conjunction with the Ship's Clerk); (f) computing—from the tally clerk's completed records—outturns and other relevant figures at definite periods, i.e., end of the shift or the day's work, in order that the exhaust figures for each hold or compartment may be calculated.

When the ship is loading, the main duties of the Ship's Clerk are: (1) maintaining liaison with the Chief Officer and Stevedore Foreman as in (a) above, especially with regard to the trim and stability of the vessel during loading. Where the ship is loading for more than one port of destination, particular care must be given to the stowage in the holds of the different commodities to ensure that her trim and/or stability are maintained with the minimum of restowing before leaving each port of discharge; (2) having a rudimentary knowledge of the Carriage of Goods by Sea Act, especially those sections relating to the stowage of hazardous goods; (3) keeping the stowage plan up-to-date, with as many details as possible, commensurate with legibility; (4) maintaining close co-operation with the Manifest Clerk and the Docks Office Outward Freight Department—the latter so that he may be kept well informed of cargo arrivals alongside and expected; (5) ordering or "taking on" shore gangs to "feed" the ship's gangs when this is the ship's responsibility; (6) maintaining contact with his opposite number on shore when this work is being performed by a separate organisation.

The Master Stevedore is usually represented on each ship by a "Ship's Foreman," whose function it is to supervise the gangs loading or discharging the ship, ensure that the best rigs and the most suitable cargo handling gear are used, and to see that the working of the ship follows the most efficient lines. A great deal depends on the generalship of the Ship's Foreman, in his hour to hour handling of loading or discharging.

A "Hatchwayman" is employed at each hatch to control the safe passage of cargo from hold to quay, etc., this he does by means of hand signals to the winchmen or crane-drivers. A good "Hatchie" is an important member of the gang, for not only does he control the safe passage of the sets between ship and shore, and vice versa, but he also influences the speed of the work to such an extent that in many ports he is treated as a leading hand. Paradoxically enough, he is regarded in other ports as an extra.

One of the chief reasons for the ship's rail being regarded as the boundary between ship and shore arises from the fact that it is

Port Operation—continued

at the rail that the "ship's" legal responsibility for cargo, as defined in the Bill of Lading, usually starts or finishes and passes from the shipper or to the consignee, according to whether the ship is loading or discharging. Emphasis is laid on the word "usually," for there are cases, e.g., on North American cargoes for London, where the Bill of Lading lays it down that the responsibility for the cargo continues with the ship for a specific period after landing. But this division of responsibility does not necessarily mean that the ship's organisation ceases to operate at the ship's rail. The practice varies widely from port to port, and, in fact, within ports, as will be shown later. In the example set out below, which is an organisation used by well known ship owners, who not only do their own stevedoring but act as stevedoring contractors for other owners, provision is made to handle the cargo ashore as well as on board.

As has already been said, organisations vary very widely indeed, and this example is only offered as a guide. This company has a separate Marine Superintendent in addition to a Chief Dock Superintendent, but many companies appoint their Marine Superintendent as their Chief Docks Executive and give him two cargo assistants, one acting as Cargo Superintendent and the other as Stevedore.

Then again, many companies employ a Cargo Superintendent on their staff, but let the stevedoring out to contract. Others let both functions out to contract. The number of inboard operators at times is quite large. It is not unusual in India, for example, to find three ships' agents interested in one ship, one representing the owners, another handling the import cargo, and a third the export cargo, and each of the latter two employing a different stevedoring contractor.*

CHIEF DOCKS SUPERINTENDENT (Shipping Company)

- Cargo Superintendent
  - Ship's Clerk
    - Loading only: Manifest Clerk; Tonnage & Measurement Computers
    - Checkers or Tally Clerks (*1 per gang*)
    - Shed Clerk (*If landing*)
    - Cargo Watchers (*As necessary*)
    - Needlemen (*As necessary*)
    - Coopers (*As necessary*)
  - Docks Office (Outward Freight Dept.) (*Loading*)
  - Docks Office (Inward Freight Dept.) (*Discharging*)
- Stevedore Superintendent (*1 in each dock*)
  - Chief Stevedore Foreman
    - Ship's Stevedore Foreman
      - Constituting 1 Gang of 12 to 15 Men: Ganger; Stevedores (*say 8 in hold*); Stevedores (*say 4 in barge*) OR Stevedores (*2 on quay for hook*); 2 Winchmen or 1 Craneman
      - (One complete gang required for each hold or purchase

The Future Development of Indian Ports

Technical Committee's Recommendations

The Ports Technical Committee, which was appointed by the Government of India early last year, has recommended a far-reaching and progressive port policy for the development of a number of ports in British India and the Indian States. The recommendations of the Committee have been referred to the maritime provincial Governments, the maritime Indian States and major port authorities for comments, on receipt of which, the Government of India will consider the policy to be followed and arrive at a decision.

The Committee comprised the following members: Sir Godfrey Armstrong (Chairman), Mr. L. W. Balcombe, Mr. M. A. Master, Mr. D. P. Khaitan, Mr. M. G. Gazdar, Mr. J. R. Galloway and Mr. A. Webster, and the terms of reference were:—

(a) Whether a sheltered deep-sea port on the East Coast of India for the accommodation of ships of large size and tonnage at all seasons of the year is required, whether their construction is feasible and if so where; also what measures are necessary for establishing it;

(b) Whether there is justification for the conversion of any minor ports on the coast of India into major ports, if so, whether such conversion is practicable; also whether there are any other projects for construction of major ports which ought to be considered;

(c) What steps are necessary to develop minor ports in order to meet probable demands of coastal shipping traffic.

General Policy

In summarising the findings of their Report, the Committee strongly expresses the view that the formulation of an all-embracing and progressive port policy should be governed by the following broad considerations:—

(a) The economic indivisibility of British India and the States;
(b) The increasing requirements of India's rapidly expanding agriculture and industries, as also the desirability of the dispersal of industries;
(c) The integration and implementation of a comprehensive, well-balanced and efficient policy of transport and its effective development in all its forms;
(d) The routing of trade through ports not to be influenced by Customs Policy;
(e) The need for a long view in the siting of new ports and the development of existing ones;
(f) The evolution of a sound policy of defence for the whole country;
(g) The geographical position and importance of India in the Indian Ocean; and
(h) The strategic importance of India in the development of a world order in the Far East.

The Committee then proceed to make the following detailed recommendations:—

Vizagapatam

As regards the first term of reference, the Committee is of the opinion that Vizagapatam on the East Coast should be developed as a sheltered deep sea port which can accommodate ships at least up to 650 feet in length with drafts up to 30 feet.

For this purpose the Committee strongly recommends that the improvement at the entrance, the expansion of the quays, the building of a dry dock and the provision of other facilities men-

*Recommended for Further Reading:—
Chapter IV Port Administration and Operations by Dr. Brysson Cunningham (particularly the organisation charts).
Chapter III (Port Administration) Port Development by MacElwee.

Future Development of Indian Ports—continued

tioned in the Report should be immediately taken in hand and the finance required for the execution of the whole project should be found by the Government of India.

The Committee suggests that, with the further development of the Vizagapatam harbour and the railway system leading thereto, a proper future lay-out of the city of Vizagapatam with Waltair is called for.

The recommendation of the Committee for the development of Vizagapatam has not made it necessary for it to examine the possibility of the establishment of another sheltered deep sea port between Vizagapatam and Calcutta, but the Committee feels that the Government may need to investigate such a possibility in due course.

Calcutta

As regards the proposals for a ship canal scheme and river training works, as suggested by the Chairman of the Calcutta Port Commissioners, the Committee feels that it cannot, on the data available before it, say that those proposals are financially sound or will effectively attain the object which they have in view.

The Committee would, however, welcome the fullest and the earliest investigation of the improvements to the navigable approaches to the Port of Calcutta and the drawing up of a scheme for that purpose, which would, without permanently affecting deep sea navigation in the upper and lower reaches of the Hooghly, provide facilities for steamers with deeper drafts to navigate to and from Calcutta at all times. They therefore suggest that the technical and other relevant aspects of this or any other scheme, with particular reference to its permanent repercussions on the upper and lower reaches of the Hooghly, should be fully examined by experts.

In connection with the proposed extension of King George's Dock, the effect of the policy of dispersal of industries on the volume of traffic that will flow through the port in future should be fully gone into.

Madras

As regards Madras, the Committee recommends that the vesting in the Madras Port Trust of the prescriptive rights over the land south of the harbour should be arranged so that the harbour waterfront can be enlarged in the only possible direction as and when the trade of the port may demand it.

The Committee further recommends that the Board may actively pursue the experiments which it has been carrying on at present for the reduction of the range. Whether these experiments are successful or not, the Committee recommends that the first stage of the wet dock scheme for four berths should be completed within a period of ten years.

Kathiawar Ports

As regards the second term of reference, the Committee is of the opinion that there is a need for a major port between Karachi and Bombay, in the Gulf of Cutch, and feels that, on the information at its disposal with particular reference to surveys made and schemes in prospect, Sika is the most promising site for the purpose; and recommends that the necessary steps for the execution of such a scheme at Sika be taken.

The Committee further suggests that with a view to providing effective and quick rail transport without transhipment to areas in Central and Upper India, on which traffic the port would need to depend largely for its economic prosperity, the laying of a broad gauge rail line from Sika to Viramgam, or any other suitable station, should form a part of the scheme.

For the successful working of the Kathiawar ports and for the effective execution of the Sika scheme, the Committee considers that the evolution of a common and unified policy for the working of the Kathiawar ports and Kathiawar railways is essential, and recommends that negotiations for that purpose may be carried on by the Government of India with the Indian States in Kathiawar.

Bhatkal

The Committee is of the opinion that the development of Bhatkal as a major port is essential for providing a good economic outlet for the trade of the large and rich hinterland of Mysore State lying behind it. From the data of the existing and potential traffic and Engineer's report relating to the scheme placed before it, the Committee considers it both a practical and good financial proposition.

In view, however, of the fact that the engineering report and part of the traffic estimates were made a generation ago, the Committee is of the opinion that a fresh report regarding engineering possibility of the scheme and fresh data of traffic should be called for.

Vizhinjam

As regards the Vizhinjam proposals of the Travancore State, the Committee is of opinion that the scheme should be carefully examined after the State has submitted a satisfactory engineering report in connection therewith.

As regards the Rameswaram Canal project, the Committee considers it as unlikely to prove a practical success from the commercial point of view.

Cocanada Harbour

Regarding the proposal for developing Cocanada Harbour into a major port, the Committee does not consider it likely to be essential in the interests of future trade, or necessary for the purpose of defence and strategy. It is, however, of the opinion that the Madras Government's request for an engineering survey of the Cocanada proposal may be complied with, and a report in connection with the scheme may be invited.

As regards the third term of reference, the Committee recommends that the relative economics of transport by sea and transport by rail should be fully investigated by the Government of India and that the policy which the Government propose to adopt for the maintenance and expansion of the comparatively cheaper form of transport should be enunciated in clear and precise terms.

In the meantime, the Committee recommends that the schemes for improvement of the minor ports framed by the Provincial Governments, subject to the Committee's criticisms in certain cases, should be carried out.

The Committee further recommends that the conservation of the coastline of India should be the direct concern of the Central Government.

[Editorial Note: The subject matter of the Report is of such importance from the point of view of Indian port development, that we propose in a future issue to give a fuller and more detailed account of the contents.]

Glasgow Port Development

Approval of an important reconstruction programme estimated to involve an expenditure of £6,275,000 was given at a meeting of the Clyde Navigation Trust held early last month. The Standing Committees have still to consider and make recommendations on the actual plans, and before these can be carried into effect, steps will have to be taken to promote a Provisional Order. Work on the project will commence as soon as authority is obtained, and it is anticipated this will be in time for a start to be made early next year.

The plan provides for the complete reconstruction of Queen's Dock to enable it to accommodate vessels of up to 500-ft. in length. Thirteen ocean berths will be provided with a depth alongside of 32-ft. at low water, compared with the present depth of 18 to 20-ft. The total length of quayage will be 2,630 yds. and a greatly improved railway system will be provided throughout the dock.

Other important provisions of the scheme involve the demolition of the central pier, which reaches 1,900-ft. into the dock; removal of the swing bridge which spans the entrance to the dock; widening of the dock entrance from 100-ft. to 295-ft.; development of the river channel where it is joined by Prince's Dock and Queen's Dock, thus giving canting space for vessels of up to 600-ft. in length; and improvement of the berthage on the north side of the river at Stobcross Quay. The scheme will also have the effect of merging Queen's Dock with Yorkhill Quay, which is used by liners operating on the North Atlantic route.

The work of reconstruction is expected to take eight years to complete, and will be so arranged that as each section of dock is completed it will become available for service.

*Recent Protection Works carried out on the Sea Wall, Bray, Co. Wicklow**

By H. A. DELAP, B.A., B.A.I., Assoc.M.Inst.C.E.

(Continued from page 234)

(4).—The Adopted Design

The season's experience showed that the three major natural difficulties to be met with were:—

(a) the low beach level—the greater part at about + 5.0 to + 6.0 O.D., L.W.O.S.T. being + 2.0 O.D. and L.W. Neaps about + 5.0 O.D.—permitted work during at most four hours in every twelve and hence presented the difficulty of finding useful employment during high water periods for the number of men required during the concentrated activity of low tides;

(b) the time of low water Spring Tides, which were essential for much of the work, and which on this coast occur in the early morning and late evening.

(c) the complete exposure of the site, the lightest onshore winds (and often no appreciable wind at all) raising a troublesome swell which called for rigidly secured form work.

These three factors suggested the casting of caissons ashore, on the esplanade. The experimental unit had been jacked up one

Caissons ready for sinking. Note Knock-out Panels, Temporary Connecting Clamps and Trestles.

end at a time, to release its base formwork without damage and should therefore be safely handled by a crane.

The condition of much of the sea wall did not, however, encourage the placing of a ten-ton mobile crane near its edge, while to place caissons on the beach by a crane on the esplanade would involve a working radius of 33 to 35-ft. No such mobile crane was available. Further experimental caissons of lighter section were therefore made, the design shown in Fig. 4 being finally adopted. This comprised two shallow units, placed one on the other to form a single box, of the same inside dimensions as before, but with side walls tapering from 12-in. to 6-in., the ends 9-in. thick and vertical to enable caissons to be placed close together end to end. A sharper cutting edge was also adopted. Large panels, recessed inside and out to leave 2-in. thick "knock-out" diaphragms, were formed in each end of both top and bottom units. The top and bottom units weighed 2.5 tons and 3.7 tons respectively.

*Paper (slightly abridged) discussed at a recent Meeting of the Institution of Civil Engineers of Ireland, and reproduced by permission.

The advantages achieved by casting caissons ashore were considerable:—

(a) Work could be spread over the tidal cycle, thus avoiding serious variation in the amount of labour required;

(b) concrete could be cast under satisfactory conditions, with adequate time for tamping, no disturbance during setting and no exposure to abrasion while immature;

(c) production of the large number of units required could be organised on routine lines, largely independent of of weather conditions, while formwork could be quickly released for re-use.

On the information thus obtained an estimate was prepared early in 1942—necessarily tentative because of the uncertainty of prices and supplies, and the possible extension of the length of wall to be protected. The total, £19,000 (which included £3,500 already expended) was for the protection by caisson-screen and buttress of the 980-ft. of wall between Steps No. 1 and No. 3 (Fig. 1), together

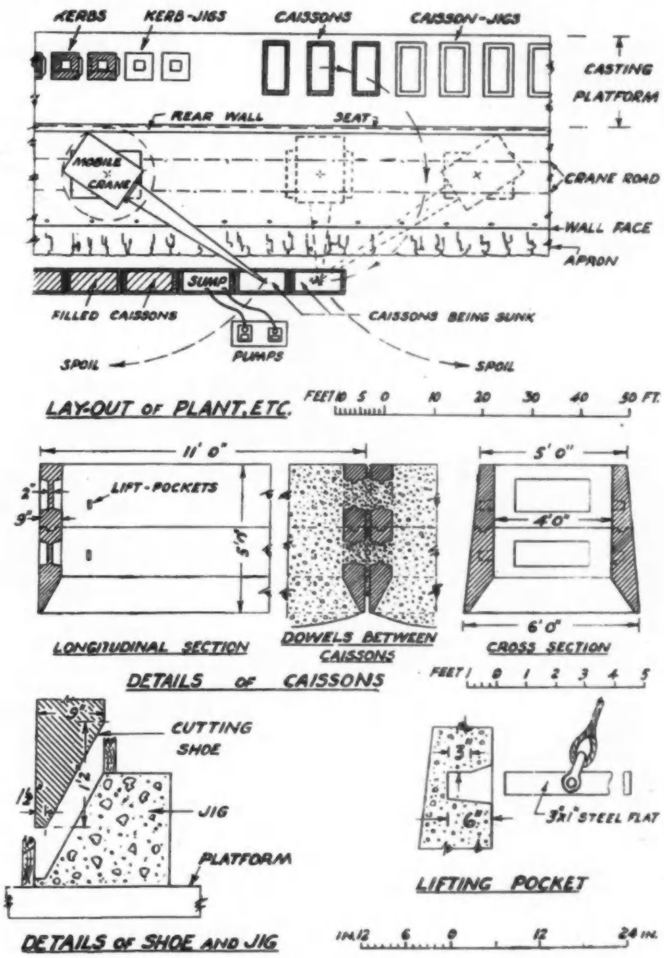


Fig. 4.

with the renewal of about 1,150 lin. ft. of deck slab (damage to which extended further than the threatened wall), and the replacement of granite copings, cast-iron railings, rear wall and seats thereon. It should be noted that the work undertaken by the Commissioners of Public Works was designed to make the wall and promenade secure. It was not their function to carry out maintenance work, and no attempt was therefore made to patch up or otherwise improve the weather-beaten face of the sea wall, nor to replace such items as the damaged access steps to the beach or esplanade. It follows that in a literal sense there is little to show for the money spent—a situation that it is hoped will continue for a long time.

Recent Protection Works carried out on the Sea Wall, Bray—continued

The legal and inter-departmental formalities occupied some months, an acute cement famine followed, and it was not until April, 1943, that the main work began. Even then some months were required to reach the estimated rate of progress. The first season had proved the possibilities, but the technique had still to be worked out, a routine for casting, handling and sinking caissons established, suitable men trained for the unfamiliar and heavy work. Plant, as suitable as could be found, had to be collected, overhauled and tested. A reserve of matured caissons was also required. The estimate assumed that an average of four caissons could be sunk per fortnight.* Since the trial caisson had taken over three weeks to sink this was optimistic; it was, however, finally achieved.

(5).—The Main Work (1943-44).

Casting Caissons.—The esplanade, 200-ft. wide and lying immediately behind the promenade for its whole length, formed a useful working space, apart from its liability to flooding during onshore gales which necessitated the building of stores and office buildings with raised floors, and discouraged large accumulations of aggregate.

On this area, immediately behind the promenade and within convenient reach of a mobile crane thereon, concrete platforms were laid on which the caisson units (and further units to be described later) were cast. Concrete base moulds were laid on this platform (Fig. 4) which acted as jigs, locating the caisson formwork accurately and forming the "negative" of the caisson's cutting edge.

A complete caisson consisted of an upper and lower unit. The latter were cast, on their jigs, with a continuous groove on their top edge. The upper units were cast sitting on the lower and thus had a corresponding tongue cast on their bottom edge, which ensured rapid and accurate location when the caisson came to be assembled on the beach.

One set of forms—the original set designed for rapid assembly on the beach—served for the total of 86 caissons (172 units) required. The later ones were naturally rough in finish, but since the whole external surface was to be buried or subject to continuous abrasion this was of no consequence. The use of permanent concrete jigs and a rigid system of bracing for form work originally designed to withstand wave blows ensured that every caisson was identical and free from distortion, within the necessary limits.

The mix used for caissons and all pre-cast units was a nominal $1:1\frac{1}{2}:3$. Cube tests at 28 days and 14 months gave averages crushing stresses of 5,022 lbs. per sq. in. and 5,438 lbs. per sq. in. respectively.

Handling of Caissons.—Caissons were handled by a 3-ton Butters mobile electric crane with a 45-ft. jib, owned by the Bray Urban Council and used in normal times to handle coal and to dredge the berths at Bray North Pier. This crane was installed on the promenade, on flat-bottom rails laid at 6-ft. 6-in. gauge on longitudinal cast-*in-situ* concrete bearers. Feed was by a 4-core rubber trailing cable, long enough to permit the entire job to be covered from four plugging points. The crane, when suitably ballasted and after a test under 50% overload at 30-ft. radius, handled the heavy (3.7 ton) units at 19-ft. radius without difficulty. To relieve the motor and brakes a 2-part purchase was rigged for handling the caisson units

Application of the lift to the caissons was obviously important. Four lifting pockets were formed in the inner faces of the side walls at minimum stress points—the calculated extreme fibre stress in the heavier units when lifted was 29 lbs. per sq. in. The pockets were relieved at the mouth so as to receive the load in the centre of the walls to minimise distortion stresses and spalling (Fig. 4). The initial lift off the jigs and final adjustment on the beach was assisted by 7-ton differential blocks interposed between crane and lifting tackle.

The first caissons cast on the jigs, which had been freely coated with oil before receiving the concrete, proved very troublesome to lift off. One unit was broken when two 10-ton jacks were used in an attempt to part it from its jig, and others were only parted by the use of pneumatic paving-breakers driven between caisson and mould, while the crane hung on with its seaward wheels just clear of the rails. The large area of contact—about 45 sq. ft. —between the cutting shoe and its negative had been overlooked; the surfaces in contact had only to develop about 2 lbs. per sq. in. in tension to lift the crane wheels. The insertion of a sheet of common brown paper avoided a recurrence of this trouble.

The programme called for sinking four caissons per fortnight. As a reserve against accident or unexpectedly easy sinking 6 per fortnight were normally cast. Nine jigs were laid down, allowing each caisson 21 days to mature. Caissons when mature were distributed along the esplanade, ready to be picked up and swung directly to where they were required. To reduce unnecessary travelling by the crane a flat wagon was built to carry 3 units, a fourth being carried by the crane, which pushed the wagon along.

Preparation of Beach.—Before caissons were placed all possible obstacles to sinking were cleared from the beach. Small boulders were removed by grab, large rocks and displaced portions of the old apron were blasted and grabbed. Displaced copings, often deeply embedded, had to be removed and brought ashore for re-use. The grab was also found effective in drawing the old timber piles.

Much trouble was caused by the violent fluctuations in beach level produced by certain winds. Heavy accumulations of gravel naturally hampered the removal of obstacles and increased the time required to sink a caisson to its designed level. Deposits were always lighter on the northern half of the site, and operations had frequently to be switched to that end when a succession of south or south-east winds had caused building up of the beach, only to be switched back to the southern end immediately work there became economic again—since every advantage had to be taken of the relatively rare periods when the southern end was low.

Placing Caissons.—Preliminary beach clearance was kept 30 or more feet in advance of caisson sinking. Just before the caisson was placed on the beach its immediate site was cleared of as much more surface material as possible—always with a watchful eye on the wall and the material under it. This final clearance was found useful in removing many small buried boulders that would otherwise have caused delays in sinking caissons.

When perhaps 30 minutes remained before the tide returned, two lower caisson units were lowered on to the site thus prepared. Caissons were placed and sunk in pairs for reasons to be described. A unit was placed in approximate position by crane, the weight being then taken by chain block until it could be eased into exact alignment by crowbars or shoulders. Final position was checked by theodolite, centre-line marks being cast on each bottom unit which when chalked were visible from concrete instrument platforms set up on the several projecting access steps. An end clearance between caissons of 2-in. was given, experience having shown that if placed closer units were very liable to become jammed by small stones or by unequal settlement during sinking.

If the beach was low, sinking of the lower units proceeded, until their tops were almost flush with the beach; otherwise their upper units were added at once. Each was placed on the lower unit upon which it had been cast, a water-tight joint being thus obtained with little trouble beyond the careful cleaning and cement-washing of the meeting edges, the groove in the bottom unit being filled with neat cement grout. It was found essential to hold the upper and lower units together positively during sinking, since otherwise the upper unit was liable to be left behind as the lower unit sank—and once the joint had opened during sinking it could never be completely cleared of gravel or grit. Temporary steel connecting clamps were bolted to holes left in the centres of the knock-out diaphragms.

Sinking Caissons.—Sinking occupied several tides—from two to eight tides per pair of caissons. To prevent the entry of beach material and reduce as far as possible the effect of wave blows caissons partially sunk, or sunk and awaiting filling, were fitted with lids during high-water periods. These consisted of reinforced concrete slabs with rebated edges fitting snugly into the open unit (top and bottom units being of the same inside dimensions), the

***The fortnight was chosen as the unit of time on which the estimate and all subsequent costs and progress returns, etc., were based, since it covered one complete cycle of Spring and Neap tides.**

Recent Protection Works carried out on the Sea Wall, Bray—continued

bearing surface carrying a continuous manilla rope washer sunk in a half-round groove. In spite of these precautions some fine material found its way in, a foot or more of sand having generally to be removed when excavation restarted. The lids helped considerably however and incidentally formed ideal platforms on which to place pumps while sinking was in progress.

The technique found most successful was only reached after much experiment, and even at the end was being improved. Two difficulties were present from the first; water and the remarkably tough nature of the clay.

The clay, which in places approached the consistency of a conglomerate, had given great trouble when the trial caisson was being sunk, every fragment having to be loosened by pick or mattock. It was believed however that a grab would deal with the clay unaided. This assumption proved wrong.

The reason should have been obvious, and is no doubt a commonplace of grabbing. A grab differs from a shovel or dragline excavator in that the external force—rope or chain—which operates it is applied approximately at right angles to the travel of its cutting teeth. As the teeth of the closing grab meet increased resistance rope tension also increases, the relative rates of increase depending on the linkage and number of parts purchase (*i.e.*, the mechanical advantage) used to close the grab.

Beyond a certain critical value the tension in the rope overcomes the weight of the grab plus the downward drag on the grab teeth of the material being excavated. When this occurs the teeth cease to close and burst up through the comparatively shallow layer of material above. If very resistant material is to be grabbed a heavy grab or high mechanical advantage is therefore required.

Grab size was limited by available space within the caisson, the size of which was limited by the need for light units. Since any increase in weight or mechanical advantage was impracticable, it became clear that some preliminary loosening of the clay would be essential before the grab could be usefully employed. Compressed air spades were found very suitable for this.

The routine adopted was to sink caissons in pairs. Inside one caisson two men operated air-spades, while a third shovelled the loosened clay towards the centre of the caisson. A fourth man tended the pump hoses, keeping a sump open and suction valves free. Meanwhile the grab was removing loosened clay from the second caisson, two men standing on trestles hung from the caisson sides, catching and guiding the grab into the mouth of the caisson.

At approximately 10-minute intervals the two gangs changed caissons, the air-spade operators and their attendants moving over to loosen a fresh layer, the grab to remove the loosened clay.

It was found best to sink a relatively deep pit within the caisson without attempting to undercut the walls. Once the middle had been thus excavated the berm supporting the cutting edge was easily broken inwards, allowing the caisson to descend. In this way small boulders or other obstructions could be more easily seen and dislodged, while any water remained in the centre of the hole.

Water was a major trouble. The flow under the sea wall and through the surface gravel necessitated constant pumping, no seal remaining long between the moving caisson and the surrounding clay. It was soon found that both grab and air-spades worked effectively only on a nearly dry floor. Water tended to wash much of the loosened material through the teeth of the grab, while even an inch of water, which was, of course, quite opaque, hampered the methodical slicing up of the clay that was found the most effective way to use the spades.

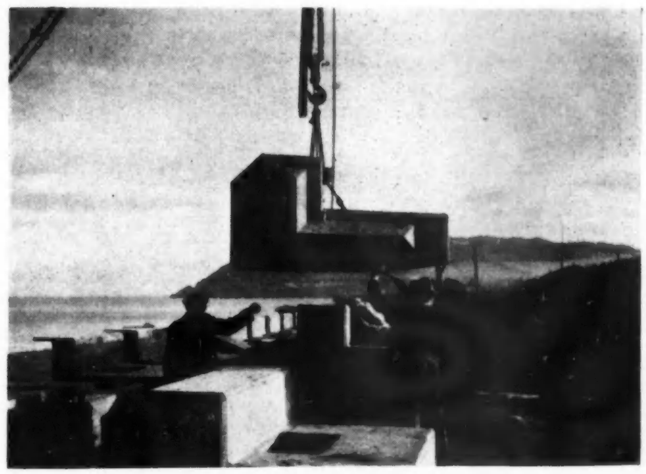
Various pumps were tried, the best combination being found in a 4-in. centrifugal—to empty the caissons initially when the tide fell—with one or two diaphragm pumps to take over and deal with the subsequent flow.

These diaphragm pumps did an enormous amount of work, sucking thick and grit-laden water from the smallest possible sumps. Diaphragm wear was surprisingly light.

Congestion within a caisson containing four men, air-spades and air-hose, two pump suction hoses, and other miscellaneous tools was considerable. It was ultimately found most convenient to use the nearest sunk caisson as a sump, placing no hearting concrete in it until the next two had reached their full depth. This sump accommodated the pump hoses and their attendant, leaving the caissons being sunk less crowded and much drier since water no longer collected in them but flowed across them to the sump.

The centre lines of the caissons and the crane road were 19-ft. apart. The 45-ft. jib thus allowed the crane to stand, while grabbing, some distance along the wall, so that material lifted from the caissons could be dumped well to seaward of future caisson sites. At the end of each 10-minute spell the crane travelled along the wall in order to stand on the side remote from the caisson containing men, thus ensuring that no loads should pass over their heads. (Fig. 4).

Filling of Caissons.—As soon as it had been sunk to the designed depth, with its toe at + 1.0 O.D., and provided it was not required as a sump, a caisson was ready to be filled. The knock-out panels in the ends of its lower unit were first broken through, the temporary connecting clamps being thus recovered. Concrete of 8 to 1 nominal mix was then placed, either by shoot or crane-skip, brought up to the level of the bottom of the knock-out panels in the upper unit. These upper panels were left intact at this stage, the 18-in. space left above the concrete being temporarily filled with sand or gravel laid on a protective layer of paper.



Pre-cast Capping Block.

The concrete passing through the knock-out panels formed heavy dowels uniting adjacent caissons (Fig. 4), while the recesses formed by the upper knock-out panels provided an efficient key for anchoring the work to be placed above.

Back-filling Between Wall Face and Caissons.—No attempt was made to replace with concrete the material upon which the wall stood. The object of the caisson screen was, as stated, to prevent further material from being removed. Before placing concrete in the narrow space (varying from 9-in. to 2-ft. wide) between caissons and the old apron, or in the wider space (approximately 5-ft.), where the apron had disappeared, only as much loose material was cleared as could be removed without disturbing that under the apron or wall. The concrete back-filling (nominal 5:1 mix) in general reached the clay only immediately against the caisson. Typical cross-sections are shown in Fig. 5, the new concrete seen projecting under the wall or apron being rammed in to fill existing voids. Drainage channels were left through the back-filling, at right angles to the wall, to deal with the flow from behind. These discharged at the junctions between certain caissons, through the narrow openings remaining above and below the longitudinal concrete dowels connecting the caissons end to end.

Capping of Caissons.—The caissons would, it was hoped, remain largely hidden for a long time. It was desirable that any capping placed on them which would project generally above beach level, should be of good appearance and able to resist abrasion. Therefore and because of the need, already noted, to spread work over the tidal cycle, shore-cast units were again adopted.

Recent Protection Works carried out on the Sea Wall, Bray—continued

Internal working-space was not required here and the units could therefore be compact and solid, pierced by a relatively small vertical dowel hole. These kerbs—as the units came to be called—were L-shaped, half-a-caisson in length (5-ft. 7-in.), with male and female ends and a recessed back (Fig. 5). The vertical dowel hole was dove-tailed from both ends to provide a positive key between caisson and kerb, and between the kerb and its *in-situ* filling. Shoulders were provided within the hole to take suitable lifting beams.

Casting, lifting and handling arrangements were much the same as for caissons, including casting platforms with jigs to locate form-work, the latter rigidly braced by wedging off steel frames to enable faces to be kept out of twist, with all important parts (*e.g.*, the negatives of male and female ends) wrought from solid pitch pine.

All exposed arrises were heavily chamfered, and when in contact showed a deep V-joint: 174 kerbs in all were cast, for which two sets of forms were used, filled respectively 56 and 118 times.

Screeds.—Before receiving their capping, caisson tops had to be brought to a uniform level, since owing to the settlement which followed the cessation of excavation, they could not be brought to an accurate level by sinking alone. Continuous screeds were therefore cast along the front and rear edges of the line of caissons, when these had been given time to settle under the weight of their concrete hearting. The screeds were brought to a level at + 6.2

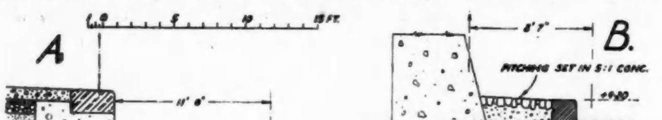


Fig. 5.

O.D., the odd 0.2-ft. being the maximum tolerance found necessary on caisson tops sunk to a nominal + 6.0 O.D. These screeds were the only fully exposed concrete cast-*in-situ* on the beach and they gave much trouble. Their volume was so small that in an 8-hour tide the smallest crack between timbers could allow many lineal yards of freshly-placed screed to melt away.

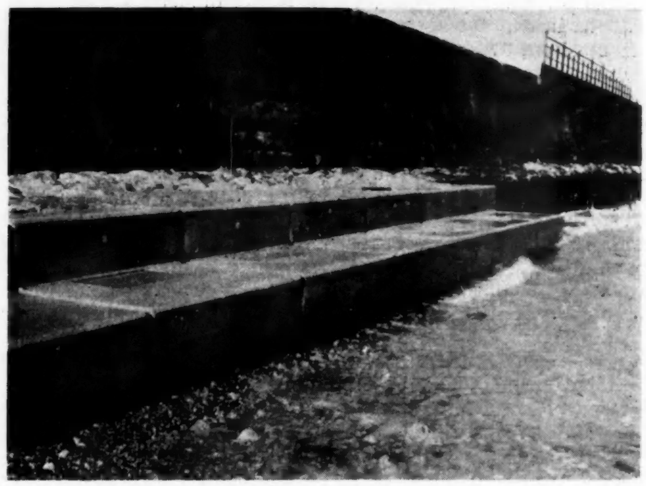
The kerbs were designed to project somewhat over the seaward screed and face of caisson, to cover any error in alignment of the latter. A projection of 7½-in. was originally adopted, but for the second half of the work experience allowed this to be reduced to 3½-in., the maximum tolerance required being 3-in.

Placing Kerbs.—The procedure was simple. The 18-in. of temporary sand or gravel filling having been removed from on top of the caisson hearting, the recess was carefully cleaned. The upper knock-out panels were broken through and 5 to 1 (nominal) concrete was placed to fill the recess and was struck off level with the top of the screeds. All grit or stones were removed from the screed tops themselves.

Kerbs were then placed in position by crane and chain-block. The male and female ends had been cast with the male end relieved by 1-in. all over except for a narrow band round the bottom and sides, where the ends actually met. When kerbs were brought into contact, therefore, their meeting ends formed a joggled vertical slot, 1-in. wide, closed at bottom and sides and open at the top. When this slot was filled with cement grout a broad area of intimate contact, joggled to resist lateral movement, was obtained. (Fig. 5).

The upper surfaces of kerbs had a 1 in 80 fall to seaward.

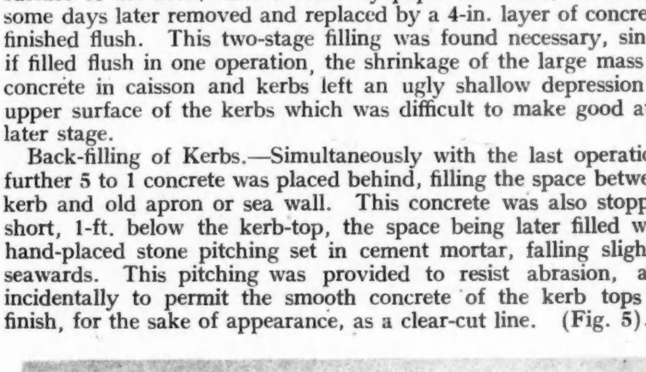
Filling Kerb-dowels.—As soon as they had been correctly aligned and while the vertical joints were being grouted, further 5 to 1 concrete was placed through the dowel hole, supplemented by old rails or other scrap pushed down as far as possible into the caisson



A number of Capping Blocks in Place.

below. The dowel filling was brought to within 4-in. of the surface of the kerb, then covered by paper and sand, which was some days later removed and replaced by a 4-in. layer of concrete, finished flush. This two-stage filling was found necessary, since, if filled flush in one operation, the shrinkage of the large mass of concrete in caisson and kerbs left an ugly shallow depression in upper surface of the kerbs which was difficult to make good at a later stage.

Back-filling of Kerbs.—Simultaneously with the last operation, further 5 to 1 concrete was placed behind, filling the space between kerb and old apron or sea wall. This concrete was also stopped short, 1-ft. below the kerb-top, the space being later filled with hand-placed stone pitching set in cement mortar, falling slightly seawards. This pitching was provided to resist abrasion, and incidentally to permit the smooth concrete of the kerb tops to finish, for the sake of appearance, as a clear-cut line. (Fig. 5).



Completed Protection Works—Northern Portion.

General Organisation of Work on the Beach.—The various operations described were carried out progressively, overlapping somewhat in both time and space, with beach clearance and caisson sinking fixing the rate of progress for the rest. Plant limitations prevented simultaneous work on all operations, since many required pumps and at least part-time use of the crane.

Recent Protection Works carried out on the Sea Wall, Bray—*continued*

Three independent gangs were normally employed:—(a) sinking caissons; (b) filling and back-filling caissons; (c) setting screeds for kerbs. The crane could thus be concentrated on excavation of caissons, the concrete for (b) being sent down by shoot from the promenade or mixed by a mixer placed on the beach. The top-filling of caissons and the placing, filling, jointing and back-filling of kerbs was a combined operation using all the men and plant on the job. It was usually continued for a week at a time, when caisson sinking, filling and back-filling had been pushed sufficiently far ahead.

Work Behind the Sea Wall.—With the completion of the protective screen in October, 1944, a new deck slab was laid for the full 1,150-ft. This slab of 8-in. unreinforced concrete, 5:1 nominal mix, was laid in 12-ft. panels, alternate panels being laid on successive days. A continuous tongue-and-groove construction-contraction joint was provided between all panels.

The rebuilding of missing portions of the wall between promenade and esplanade and the replacement of the granite coping stones recovered from the beach completed the work undertaken by the Commissioners of Public Works.

(6).—Possible Future Extensions

Reference has been made to the possibility of extending the protection work should the beach continue to fall seriously once the clay has become exposed, or should a further length of wall be in danger. The latter needs no comment; the caisson screen can be extended along the wall at any time. Should the beach fall so as to expose the caissons seriously, it would be a simple matter to drive sheet piling along their seaward face. No serious trouble in driving should be experienced since the kerbs would form a ready-made, steady and level platform, the face of the caissons guiding the piles down, while excavation has shown that few boulders of any size need be expected below the surface of the clay.

(7).—Conclusions

Small unreinforced pre-cast units would appear to have possibilities for a variety of works. Construction and handling offer no serious difficulty provided good concrete is used and racking stresses or sudden blows are avoided. Of the 344 pre-cast units used in these works, six (or 1.75%) were broken or cracked. One lower caisson unit was broken when hydraulic jacks were used to force it off its jig; one upper caisson unit was broken on the beach by a swinging grab, its lower unit being cracked; one complete caisson (2 units) was badly cracked when, having become jammed between adjacent caissons during sinking, an attempt was made to force it down by blows of a light piling hammer. One kerb unit was broken up by heavy swell soon after it had been placed on its screed, and before its dowel was hard. None of these failures were due to inherent weakness in the unit, but they indicate the type of treatment that should be avoided.

The sinking of small open caissons also seems to offer possibilities, as a useful alternative to other methods of under-pinning or foundation work, in particular close to structures having doubtful foundations themselves where driving piles would be dangerous. This work is likely to be slow and expensive, though it is certain that with ample and suitable plant in good order better results could be obtained than those described.

One point should be emphasised. The success of this type of work depends very largely upon the people on the spot—Resident Engineer, foreman and men. Long spells of heavy work in confined space, often outside normal hours and by artificial light; cold, wet, mud, and the noise made by compressed air tools working in a small concrete box; endless struggles with temperamental pumps and worn-out air-spades—such conditions call for enthusiasm among the men and considerable leadership from a foreman who, while directing an attack against a caisson apparently suspended in mid-air with six clear inches all round under its toe, must keep one eye on the wall foundation, one on the returning tide, and a third on the grab swinging somewhere overhead. Freedom from serious accident in the work described must be attributed to the care of the Resident engineer and foreman, and to the crane driver, who in 1,650 hours working had a completely clean sheet.

Acknowledgments

The Author wishes to acknowledge his indebtedness to the Commissioners of Public Works for permission to present this Paper; to Mr. J. P. Candy, Chief Engineer, Office of Public Works, for his advice and encouragement; to Mr. J. P. Doyle, Deputy Chief Engineer; Mr. P. J. Sexton, Engineer-in-Charge, Marine Section; and the staff of the Marine Section of the Office of Public Works, who collectively evolved the design and methods described; to Mr. A. Connaughton, Resident Engineer; to Mr. E. M. Murphy, Engineer to the Bray Urban Council, for his helpful co-operation throughout the work; and to Mr. M. O'Kelly, Office of Public Works, for his assistance in preparing the drawings for the Paper.

Improvements at Hull Docks

Speaking at Hull on the 3rd January last, Sir Ronald Matthews, Chairman of the London and North Eastern Railway Company, intimated that as part of a programme estimated to cost £7,000,000 in order to bring the port fully up-to-date, the Company proposed to spend £1,750,000 on the reconstruction of the Riverside Quay, £1,250,000 on the construction of a south-west arm to the King George Dock, and a further £1,250,000 on a number of smaller schemes.

Negotiations concerning these three items have been proceeding between the Hull Incorporated Chamber of Commerce and Shipping and the Railway Company since 1944, and at a meeting in December last, it was agreed that, in return for additional revenue from increased charges, a minimum of £4,000,000 should be spent by the Railway Company on docks other than the fish docks. It is understood that the revision of the dock dues and charges is still under discussion, and it is hoped that agreement will be quickly reached.

With regard to the discussions with the fishing industry, which have been conducted separately, a scheme has been prepared for the reconstruction of the St. Andrew's Dock at an estimated cost of £2,250,000.

Lloyd's Register of Shipbuilding Returns

The statistics issued by *Lloyd's Register of Shipping* regarding Merchant vessels under construction at the end of December last show that in Great Britain and Ireland there was an increase of 62,184 tons in the work in hand as compared with the figures for the previous quarter. The present total of 1,937,062 gross tons is also greater by 324,252 tons than the tonnage which was being built at the end of December, 1945, and has not been exceeded since March, 1922, when the total recorded was 2,235,998 tons.

An encouraging feature is the continued increase in the tonnage intended for registration abroad or for sale. This figure has risen progressively during 1946 and now stands at about 478,000 tons, or 24.7 per cent. of the tonnage at present being built in this country.

The tonnage of merchant vessels under construction abroad at the end of December is shown as 1,741,419 tons gross, which is 47,138 tons more than that recorded at the end of September last, when no figures were included for Danzig, Germany, Japan, Poland and Russia, and the information concerning France was incomplete. These reservations still apply, but the figures shown for France are more comprehensive than previously. The leading countries are: United States of America, 326,753 tons; Sweden, 248,205 tons; France, 196,459 tons; Holland, 196,358 tons, British Dominions, etc., 167,799 tons (including Canada, 110,120 tons); Italy, 162,390 tons; Denmark, 158,143 tons; and Spain, 107,760 tons.

The total tonnage under construction in the world (apart from those countries excluded, as mentioned above) amounts to 3,678,481 tons gross, of which 52.7 per cent. is being built in Great Britain and Ireland, and 47.3 per cent. abroad.

The vessels being built in the world at the end of December include 44 steamers and 59 motor ships of between 6,000 and 8,000 tons each; 30 steamers and 61 motor ships of between 8,000 and 10,000 tons each; 25 steamers and 34 motor ships of between 10,000 and and 20,000 tons; and 6 steamers and one motor ship of between 20,000 and 30,000 tons.

The Port of Preston

The estuary of the River Ribble on the West Coast of England, lies between the estuaries of the River Mersey on the south, and of the River Wyre on the north. The port extends from Formby Point to a little south of the Central Pier at Blackpool, a distance of approximately 14 nautical miles in the south and north direction, and in an east and west direction 16½ nautical miles from Nelson Buoy, marking the entrance to the river and the "Fairway" to Preston Dock.

The "Albert Edward" Dock is 40 acres in area, and has an entrance basin 4¾ acres, and is situated on the northerly margin of the Lancashire coalfields, to which it is the nearest port, and is close to the large industrial populations of East Lancashire and West Yorkshire, and although there are other ports near, Preston is the nearest port to three millions of people.

Generally speaking, the navigation is an easy one, and compares favourably with neighbouring ports. In common with most north-west English ports the navigation is tidal.

Dredging Operations

For some years prior to the late war intensive dredging was prosecuted in deepening the stretch of the river from the dock entrance to 8 miles below, and it then became apparent that in order that larger vessels could take advantage of this increased depth in the upper reaches, a greater depth of water over the bar was essential. Consequently in 1931 an Act was obtained authorising the extension of the training walls at the sea end of the works from 14½ to 16 miles. The work commenced in May, 1932, on the South Training Wall extension, the deep channel at this date, after leaving the trained channel at 14½ miles, took a southerly course across the line of the intended south wall extension, the line of the intended channel being occupied by a formidable sand bank showing dry 2-ft. at low water of Ordinary Springs. Consequently the training wall had to be constructed across the swiftly-flowing channel carrying a depth of water up to 20-ft. below Low Water. This made the work of construction more difficult and greatly retarded progress. The gradual extension of the south training wall was accompanied by a gradual improvement in the navigable channel following the line of the wall, the training wall having directed the tidal water to the best advantage on to the bank, eroding the bank to such an extent that what was a sand bank stretching across the line of the intended channel and 2-ft. above low water in 1933, was in 1939 a depth of water of over 24-ft. below low water.

Improvement in the estuary beyond the end of the wall had also been obtained, the bar having been deepened by 4-ft., and the deep water channel then being in direct line with the wall and not as formerly across the line of the intended wall. Unfortunately due to war restrictions this work was suspended in October, 1939, by Government order, and the bucket dredgers and hoppers laid up. The wall being constructed of stiff, tenacious clay and topped with gravel dredged from the bed of the river by bucket dredger, loaded into steam hoppers with bottom doors and tipped on the site of the wall, has naturally settled during the past 7 years, with the consequence that a less quantity of tidal water is to-day constrained by the wall, and some deterioration in condition of the channel has resulted. This will be remedied by resumption of work, which is intended at the earliest possible moment.

War-Time Conditions

The adverse effect of the late war on the trade and income of the port was intensely felt for about the first 18 months. In 1941, owing to the Government's decision to make Northern Ireland a military base, Preston was made one of the principal ports for shipments of military stores to Northern Ireland, with the consequential increase in port revenue, mainly due to the increase of rates for cargo dues, and shipping dues, and not to increased number of vessels.

The increase in number of vessels did not take place until preparations were being made for "D" Day, when some Irish traffic was diverted to Preston from the principal invasion ports; much of this traffic was new to the port, and the dockers were unaccustomed to its handling, but they readily adapted themselves to the change and earned deserved commendation for the promptness with which vessels were turned round, at times under very trying circumstances.

Trade of the Port

Year ending 31st March	Number of Vessels	Registered Tonnage	Imports Tons	Exports Tons	Total in and out Tons
1938	1,635	609,708	870,262	317,128	1,187,390
1939	1,466	550,418	663,257	308 326	971,583
1940	1,401	462,983	575,682	388,091	963,773
1941	1,175	378,040	346,082	380,570	726,652
1942	1,139	358,876	452,288	257,145	709,433
1943	1,104	332,471	369,309	312,301	681,610
1944	2,121	499,454	441,280	708,568	1,149,848
1945	1,589	407,775	392,416	515,900	908,316
1946	1,611	390,585	402,369	543,841	946,210

REVENUE AND EXPENDITURE

Year ending 31st March	Gross Income £	Working Expenses £	Working Surplus £
1938	267,832	186,926	80,906
1939	217,654	168,815	48,839
1940	200,228	158,598	41,630
1941	187,541	175,625	11,916
1942	304,031	236,325	67,706
1493	192,517	231,916	60,600
1944	330,727	267,066	63,661
1245	363,453	310,582	52,871
1946	334,308	295,070	39,239

Dock Equipment

During the late war improvements and additions were made to the dock equipment to cope expeditiously with the varied traffic handled, the main feature being—the east end of the north side dock quay was concrete-surfaced and four lines of wagon rail tracks laid on concrete foundations. Crane tracks were laid three 2-ton Portal electric luffing cranes were erected thereon.

Two 3-ton mobile runabout cranes and an additional locomotive were acquired.

Upwards of one mile of new rail roads were laid down.

The South Side Dock Quay, rail and crane roads were relaid on concrete foundations for the purpose of accommodating a further four new Portal electric luffing cranes.

Electric pumps were installed in hydraulic power houses in replacement of steam pumps for the actuation of the dock gates and other numerous hydraulic plant.

The dock was illuminated by electricity in substitution of the previous gas lighting.

The present dock equipment and facilities are admirably suited to accommodate all classes of traffic and give prompt turn-round of vessels; at least 50 per cent. more than the maximum pre-war traffic could be handled with ease.

Future Improvements

Maintenance of the navigable channel and training walls being prejudicially affected by reason of war-time restrictions, the authority are now taking steps to restore the navigable channel to pre-war condition and thence further deepen it, for which purpose they are now having built suitable sea-going suction dredgers, capable of dredging to a depth of 45-ft.

Improvements and additions to the dock equipment are to be actively pursued to meet future contemplated requirements of shipping, and to enhance the reputation of the port. Such process of modernisation will be welcomed by shipowners and masters and those actively associated with the port.

At the present time the problem of making up arrears of repairs arrested by the war are well in hand.

The Ribble Navigation and Preston Dock undertaking is the property of the Corporation of Preston, and is administered by the Ribble Committee, consisting of 10 members of the Town Council who are alive to the need of developing their port with all possible speed.

Traffic at the Port of Bristol.

Statistics recently issued show a considerable increase in the number of coastwise vessels using the Port of Bristol during the year ended December 31st, 1946, as compared with the year 1938. Last year a total of 8,228 coastwise and 575 foreign vessels entered the port, the 1938 figures being, 7,404 and 1,166 respectively.

Notes of the Month

St. Andrews Harbour Inspection.

Dundee Harbour Trustees have agreed that their general manager and engineer, Mr. Norman A. Matheson, M.Inst.C.E., M.Inst.T., should give his services to St. Andrews Town Council to inspect the harbour there. He is to report on the works required to put the harbour in a proper state of repair and also give an estimate of the cost.

Suez Canal Receipts.

Figures issued by the Suez Canal Company show that the amount of receipts, in pounds sterling, collected from vessels using the canal during 1946 totalled £12,246,300, as compared with £9,583,700 for 1945 and £9,664,500 for 1939. Receipts during December, 1946, were £1,058,700, compared with the December, 1945, figure of £1,073,300.

Improvements at the Port of Shanghai.

It is reported that the Central Trust, under the auspices of the Chinese Government, has completed a long-term plan for the creation of a deep-water harbour from Woosung to within 5 miles of the business centre of Shanghai, and the construction of a number of new wharves along the Shanghai waterfront. The immediate work to be undertaken includes the repairing of the badly-damaged warehouses, the installation of new cranes along the wharves, and the dredging of the Whangpoo River.

New Silos at Port of Samsun, Turkey.

Three new silos of a total capacity of about 3,000 tons are now in use at the Port of Samsun, in addition to two depots belonging to the Railway Administration with a total capacity of 1,500 tons. A jetty close to the silos and intended exclusively for the loading of cereals is nearing completion and the handling capacity of the port at present is 600 tons loading per day and 300 tons discharging. These services are now in the hands of the State Port Authorities.

Port of Londonderry Annual Meeting.

Presiding at the annual meeting of the Londonderry Port and Harbour Board held recently, Captain B. F. McCorkell (chairman) said that Londonderry had emerged from the first complete post-war year fairly well. The tonnage of vessels entering the port during the past year amounted to 737,014 tons, as compared with 766,426 tons in 1945. Revenue from all sources amounted to £45,058 and was a little in excess of that of the previous year. The total expenditure amounted to £44,245, slightly less than in 1945.

New Floating Dock at Bombay.

A floating dock capable of accommodating ships up to 50,000 tons and costing one-and-a-half crores of rupees (£1,125,000) has just been completed at Bombay. The dock, which is 885-ft. long, 172-ft. wide, and 75-ft. high, will be put into commission soon by the British Admiralty. Twenty thousand tons of steel produced in India were used in its construction, which was commenced in September, 1944. The dock was originally intended for Singapore, but will now be diverted to a port without dry-dock facilities.

French Pitwood for South Wales.

Arrivals of French pitwood, which stopped about the middle of last year, are to be resumed. It was reported recently that a new arrangement had been entered into for the supply of 30,000 tons of French timber for the Welsh mines, to be delivered before the end of February. Before the war France sent Wales about 300,000 tons of pitwood annually. In December, 1945, a Welsh deputation visited France and entered into agreements for the supply of 40,000 tons of wood, and it was then anticipated that the trade would grow. The French authorities, however, later refused export licences for further supplies owing to disagreement over the question of price.

Port of Belfast Traffic.

An improvement in the tonnage returns for the Port of Belfast was referred to at a recent meeting of the Belfast Harbour Commissioners, when it was reported that the total arrivals for 1946 were 217,778 tons, an increase of 50,424 tons over the previous year, and 30,888 tons over 1938.

Congestion at the Port of Rio de Janeiro.

On account of the congestion in Rio de Janeiro, which is partly attributed to a shortage of warehouse space and lighters, the U.S.A. Moore-McCormack Lines are sending 27 lighters there to help alleviate the position. The total cost is estimated to be $1,200,000 and each lighter will have a capacity of 500 tons. The first is expected to leave New York early this month.

Dutch Order for Dock Cranes.

An order for eight level luffing dockside cranes has been placed by the Rotterdam Harbour Authorities with the Clyde Crane & Engineering Company, Mossend, Scotland. This is the second large order which the firm have received from Holland, a contract to supply 20 similar cranes to Amsterdam being signed in September last. The total value of these two orders is approximately £400,000, and, in addition, two cranes are to be built for Harlingen.

New Cold Storage Building at Southampton.

A new five-storey building for cold storage, estimated to cost £250,000, is to be erected by the Southern Railway at Southampton Docks. It will be equipped with the most up-to-date refrigerating plant with cold space provided for 6,000 tons of meat, fruit and dairy produce from the colonies. The building itself will be constructed of reinforced concrete, and have direct access from the dockside as well as by road and rail, and will replace the one destroyed by enemy action in 1940.

Marseilles Port Traffic.

The Port of Marseilles, which was badly damaged during the war, is now handling a greater cargo and passenger traffic than in pre-war years. During 1946, 8,090,904 tons of merchandise were loaded or unloaded, compared with 6,306,171 tons in 1938. The number of vessels using the harbour last year was only 5,100, compared with 13,958 in 1938, the tonnage being 20,110,280 tons, compared with 29,305,149 tons. The traffic included 149 Norwegian, 93 United States and 72 British vessels.

Repairs at Port of Liverpool.

Among the more urgent repairs now in hand for the Mersey Docks and Harbour Board, Liverpool, are the rebuilding of sheds in the Gladstone, Alexandra, Canada and Huskisson dock systems, the replacement of hundreds of damaged shed doors all over the dock estate and the reconstruction of the Riverside Station. With regard to new works, it is hoped to complete the new Waterloo entrance within the next 12 months, and to provide new storage accommodation for the timber trade at the north end of the estate. In all these plans, the Board is co-operating with the users of the port to find a satisfactory solution of joint problems.

Southwold Harbour Improvements.

The construction of a barrage, combined with a road crossing over the River Blyth, and improvements to Southwold Harbour were considered at a recent meeting of the East Suffolk Rivers Catchment Board at Ipswich. The proposed barrage would cross the river near the railway bridge, and the present opening at the entrance of the harbour would be eliminated by making the north pier overlap the south and curve southward. Capital costs are estimated to be £77,500 for erection of the barrage, provision of a road crossing and sealing of breaches in the banks; and £27,000 for harbour improvements. A copy of the proposals has been forwarded to the Ministry of Agriculture and Fisheries.

Reinforced Concrete Dry Docks

An Article for Students and Junior Engineers

STANLEY C. BAILEY, Assoc.M.Inst.C.E., F.G.S.

General

DRY DOCKS were formerly built of brickwork or rubble masonry, and even of timber as one at Baltimore, Maryland, U.S.A., which was constructed about 1900, and a floating dock also of timber for 10,000 tons lift at Hoboken, New Jersey, U.S.A., and later of Portland cement concrete with granite or other hard stone copings, altars, and facings to the walls and cills, while in some instances the walls were faced with 4½-in. thickness of blue brick from L.W.S.T. level to the coping, the floors were either entirely paved with granite, or it was restricted to the lines of the keel and bilge blocks for a width of about 6 or 8-ft.

In most modern dry docks constructed of cement concrete, the use of granite has been largely dispensed with, this has been due to the great improvement in the manufacture of stronger cement, and granite is now only used for copings, and caisson or gate bearings on the walls and cills also occasionally under the keel and bilge bocks, the walls and floors being faced with 6 inches thickness of strong fine concrete in the proportions of 1—1½—3, or 900 lbs. of cement (allowing for cement at 100 lbs. per cubic ft.),13.5 cub. ft. of sand, and 27 cub. ft. of gravel or broken stone up to ¾ inch gauge. Displacers or stone "plums" of 3 to 4 cubic ft. are sometimes embedded in the walls and floor and surrounded with 2 to 3-ft. or more thickness of concrete, that in the floor being in the proportions of 1—2—4=700 lbs. cement to 14 cub. ft. sand, and 28 cub. ft. of gravel; and in the walls 1—2—5 or 700 lb. cement to 14 cub. ft. of sand, and 35 cub. ft. of gravel. In cases where the floors are liable to hydrostatic pressure from below under a head of water up to H.W.S.T., they have been made of considerable thickness amounting to $\frac{1}{5.5}$ or $\frac{1}{4.5}$ of the floor width for water pressure heads of 35 to 70-ft. respectively under the floors, because the safe tensile strength of cement concrete is limited to 60 lbs. per sq. inch or 3.85 tons per sq. ft., the ultimate tensile strength being about 240 lbs. sq. inch, or 15.4 tons sq. ft. while the safe shearing stress is taken at 80 lbs. per sq. inch = 5.1 tons sq. ft. the ultimate being about 300 lbs. sq. in. or 19.2 tons sq. ft. and usually no steelwork is embedded in the concrete to take such stresses, which would occur if the floor is treated as a beam with fixed ends; although in a few docks, short lengths of horizontal steel rails laid transversely have been inserted at intervals in the floors at their junctions with the walls.

In the building of dry docks the usual procedure is to construct the walls first in excavated and heavily timbered trenches to allow the walls to settle before the floor is formed, and then to excavate cross trenches from wall to wall, about 30-ft. wide, in which to form the floor, a space of 30-ft. is left as an earth "dumpling" between the cross trenches, and when the floor in these has been concreted, the "dumplings" of earth are excavated, and the floor completed; this is done to prevent any forward move of the walls while the earth filling behind them is being proceeded with. Consequently the junctions of the floor with the walls are not so strong as they would have been if the lower portions of the walls, and the full thickness of the floor could be built continuously, and the joints would not be so liable to contraction cracks during the setting of the cement.

The concrete for the floor in the cross trenches should be deposited continuously, so far as possible, for the same reason. The construction of thick floors is based on the theory that they act as inverted arches when under hydrostatic pressure from below, and a safe compressive stress of from 500 to 600 lbs. per sq. inch, or 32.14 to 38.57 tons per sq. ft. is allowed, the ultimate being about 3468 lbs. sq. in. or 223 tons sq. ft. for 1—2—4 concrete 8 days old, which may rise to 5738 lbs. sq. in. or 368.8 tons sq. ft. when 5 months old.

But the arch theory can only be true when the walls acting as the abutments are capable of withstanding the thrusts of the arch action, and are not pushed back, otherwise the floors must act as constrained beams, which they are incapable of doing because of their low tensile strength, although the concrete would be able to withstand the maximum shear on the floor.

It is a question of the relative cost of forming a thick floor which will be stable and watertight, or the alternative of a thin one perforated with holes to allow the water to escape into the dock and be pumped out by the drainage pumps.

It depends largely on the character of the ground, but should it consist of sand, gravel, and other alluvial materials, a considerable quantity of water may be expected, and continual pumping will also be required in the trenches during the construction of the dock. In the cases of dry docks founded on clay which is more or less impervious to water, there may not be water pressure under the floor, but as the rubble and other filling at the backs of the walls will probably allow water to accumulate, they should be calculated to withstand hydrostatic pressure.

If it is decided to construct thin walls and floor for a dry dock in ground more or less waterlogged, the walls are perforated with either iron, zinc, or stoneware pipes about 2 inches diameter at frequent intervals, provided with tidal flap valves on the dock side and the floors with vertical 4-in. to 6-in. diam. pipes closed at the floor level with similar valves.

In cases where there is little or no external water pressure, as in the instances of docks founded on solid rocks such as granite, hard limestone and sandstone, only thin walls and floors from 12 to 18 inches thick will be necessary, all surface cracks and fissures in the rocks should be cut out and cleaned for filling with fine concrete or cement grout at 90 bs. pressure per sq. inch. Where the rock consists of chalk, soft limestone or sandstone, the floor concrete should be dovetailed into the rock in strips 3 to 4-ft. wide, across the floor, at similar spaced intervals.

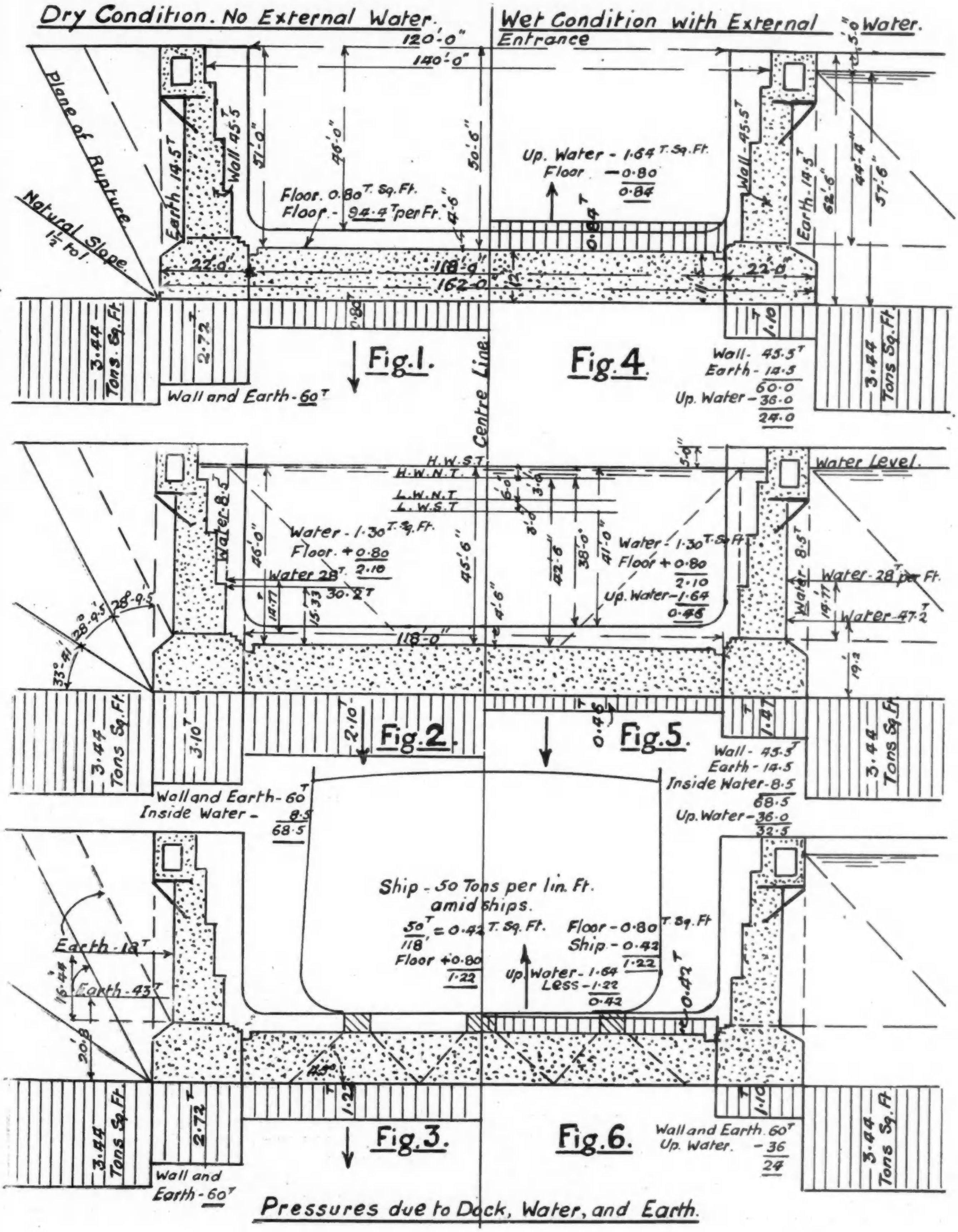
Several instances have occurred in which even thick dry dock floors have been forced up and have cracked longitudinally either down the centre or at the junctions with the walls. This has been due in some cases to unequality of pressures on a soft subsoil, the heaviest being under the walls which may amount to 3 tons per sq. ft., while that under the floor may only be 1 ton per sq. ft. The ground under the walls compresses and sinks under the load, probably because it was saturated with water and muddy when the concrete was deposited, and if the adhesion of the floor to the walls is strong, the walls will carry the floor down with them, thus forming a central longitudinal crack in the floor.

On the other hand should the junctions of the floor to the walls be weak, the cracks will appear at the toes of the walls, shearing having taken place.

In other instances where the floors have not been sufficiently thick the heavy arch like thrusts caused by upward water pressure have forced the walls back, because the thinner the floor the flatter will be the arch and the greater the thrust and vice versa. The floor rises and cracks in the middle and crushes at the toes of the walls inside the dock; so that when limiting the maximum safe pressure to be put on the ground, if the weight under the walls exceeds the amount, thin piling under the walls should be resorted to, in which case thinner walls may be constructed, as the pile heads when buried in the concrete will assist them to resist the arch thrusts.

As the foundation of some dock walls are so much as 60 or 70 feet deep below the coping level, if this has been excavated, the weight of soil at those depths would be about 3.3 to 3.8 tons

Reinforced Concrete Dry Docks—continued



Reinforced Concrete Dry Docks—continued

per sq. ft., so that a wall whose weight does not exceed these amounts should be safe from settlement; but if the excavation is of much lesser depths, the ground will probably not be capable of safely carrying the weight of the walls, and shearing between the walls and the floor may take place.

Reinforced Concrete Dry Docks

Dry docks built of mass concrete alone cannot be considered as homogeneous structures distributing the loads equally over the foundations because of their weak tensile and shearing resistances, also on account of the great number of joints that are necessary when dealing with large masses of concrete, and the time required for it to harden which may extend for periods of 9 or 12 months, in the meantime the walls and floor are settling down and may develop hidden cracks.

These difficulties can be overcome by employing thinner concrete in the walls and floor, and reinforcing it with steel rods, the concrete will harden or set more rapidly and the dock will become a homogeneous structure, capable of distributing its weight uniformly over the foundations, this has been accomplished in the cases of reinforced concrete floating docks, and the principle has been applied to dry docks, one such dock of reinforced concrete having been built at Amsterdam about 1924. A reinforced concrete floating dock at Trieste measured 210-ft. 6-in. x 68-ft. 10-in. x 34-ft. high outside, and 171-ft. 2-in. x 49-ft. 2-in. x 23-ft. high inside, while at Minden in Germany there was one 262-ft. x 12-ft. x 10-ft. high inside dimensions, and several have lately been constructed in the British Isles.

In the design of a reinforced concrete dry dock, to reduce the thickness, the walls may be treated as cantilevers above the floor level, and subject to lateral triangular earth or water pressures, the latter will be the heaviest, and the floor may be considered as a beam with fixed ends, subject to upward water pressure.

The thickness of concrete in the floor will depend upon how much steelwork can be conveniently placed under the floor surface per lin. ft. of dock, for tension purposes, because if the steel rods are too crowded together, they cannot easily be surrounded with concrete, the thinner the floor is made, the greater will be the stresses in the steel and concrete, and vice versa. The thickness may vary from 1-10 to 1-8 of the floor span.

Figs. 1 to 6 are sketches of the cross section of a proposed dry dock which is to be reinforced with steel rods, it is to be 1000-ft. long, 140-ft. wide at coping level and 118-ft. at floor level, with a depth of 51-ft. from coping to floor at the walls, and 62-ft. 6-in. total depth outside, the floor is 12-ft. thick or $\frac{1}{9.83}$ of the span.

Each wall is 22-ft. thick at the base, and the total width is 162-ft. The entrance which is 120-ft. wide, with a depth of water at H.W.S.T. of 41-ft. over the cill, has vertical walls, which are splayed in plan outside the caisson groove, so that the caisson can be placed in position across the entrance, or removed for repairs.

The floor is assumed to be under hydrostatic pressure from below due to a head of water of 57-ft. 6-in.

The Figs. show the normal pressures in tons per sq. ft. that would come on the ground, due to the weights of the walls, floor, vertical earth and water pressures, and of a ship in the dock.

The weights on the ground are based on the assumption that the dock is not reinforced, and the extra pressures on the ground due to the lateral earth and water forces are not shown.

When reinforced, the loads from the floor and walls would be equally distributed over the whole width of the base.

The heels given to the backs of the walls are for the purpose of resisting floatation when the whole dock is waterborne, as they carry masses of earth.

The resistance to floatation at H.W.S.T. will be as follows, per lin. ft. of dock, viz:—weight of floor—94.4 tons, 2 walls—91 tons, 2 earths on heels—29 tons, a total of 214.4 tons. The earth weights on the heels of the walls will probably be more than 29 tons, as the line of fracture will be on a slope of 60° or 70° and not vertical as shown.

The displacement of the dock at H.W.S.T. will be 8976 cub. ft. per lin. ft. = 256.4 tons, an excess of 42 tons over the weight of the dock.

If suction on the ground at the bottom of the dock = 1 cwt. per sq. ft. or 8.1 tons on 162-ft. and the friction of the earth against the walls is 6 cwts. sq. ft. this will amount to 62-ft. 5-in. x 1-ft. x 6 x 2 = 37.5 tons, a total of 45.6 tons, so that the dock should be safe against floatation.

From experiments that have been made in pulling concrete blocks out of ground consisting of gravel, clay and soft marl, the friction amounted to from 7 to 9 cwts. per sq. ft., while the friction in pulling 12-in. x 12-in. timber piles driven 30 to 35-ft. into silt and clay was 9 cwts. sq. ft. and 5 of the piles refused to be drawn and were pulled until they broke in two.

Some 14-in. x 14-in. timber piles driven 15-ft. into sand and gravel gave friction equal to 10 and 15 cwts. per sq. ft. when pulled. The weights assumed in calculations for the dock under consideration are for reinforced concrete—149.3 lbs. per cub. ft. (15 cub. ft. per ton); earth—124.4 lbs. (18 cub. ft. per ton); and for sea water—64 lbs (35 cub. ft. per ton).

The dead weight of a ship in the dock has been taken at 50 tons per lin. ft. of midship section.

A dry dock constructed of mass concrete of similar internal section and dimensions to the reinforced concrete dock shown in Figs. 1 to 7 would probably require a floor 20-ft. thick at the centre, and 18-ft. at the walls, the walls being at least 25-ft. thick at the base and 70-ft. high.

The total weights would be for the floor—140 tons; walls 144 tons, with earth on the offsets at the backs of the walls = 22 tons, a total of 306 tons per lin. ft., while the displacement at H.W.S.T. would be 305.4 tons, and the cost per lin. ft. of the body of the dock would be about 1.224 times greater than that of a reinforced concrete one.

If the dock is empty the average weight on the ground from the floor will be 1.18 tons sq. ft. and if full of water up to H.W.S.T. or 45.5-ft. depth, the weight will be 2.48 tons sq. ft.

Under the walls the load = 3.32 tons sq. ft., while the weight of 70-ft. depth of soil = 3.88 tons sq. ft.

In the sketches shown by Figs. 1 to 3, the left hand half cross sections of the dock are for dry conditions, with no water pressures outside, while the right hand half cross sections (Figs. 4 to 6) are for external hydrostatic pressures.

In Fig. 1 the weight of the floor 12-ft. thick is 94.4 tons per lin. ft. of dock, and the pressure on the ground is 0.80 ton per sq. ft.

In Fig. 2 the weight of water in the dock up to H.W.S.T. (45-ft. 6-in. head) is 153.4 tons + floor = 94.4, or 247.8 tons = 2.10 tons sq. ft.

In Fig. 3 with a ship in the dock = 50 tons per lin. ft. + floor = 94.4, at total of 144.4 tons = 1.22 tons sq. ft.

In Fig. 4, with the dock under hydrostatic pressure, due to a head of 57-ft. 6-in., the pressure under the 118-ft. width of floor will be 193.5 tons less the floor weight of 94.4 tons = 99.1 tons, or an upward pressure of 0.84 ton sq. ft.

In Fig. 5, the water in the dock and floor weigh 247.8 tons, less the upward pressure of 193.5 tons = 54.3 tons or 0.45 ton sq. ft. on the ground.

In Fig. 6, the ship and floor weigh 144.4 tons less the upward the upward pressure of 193.5 tons = 54.3 tons or 0.46 ton sq. ft. upwards.

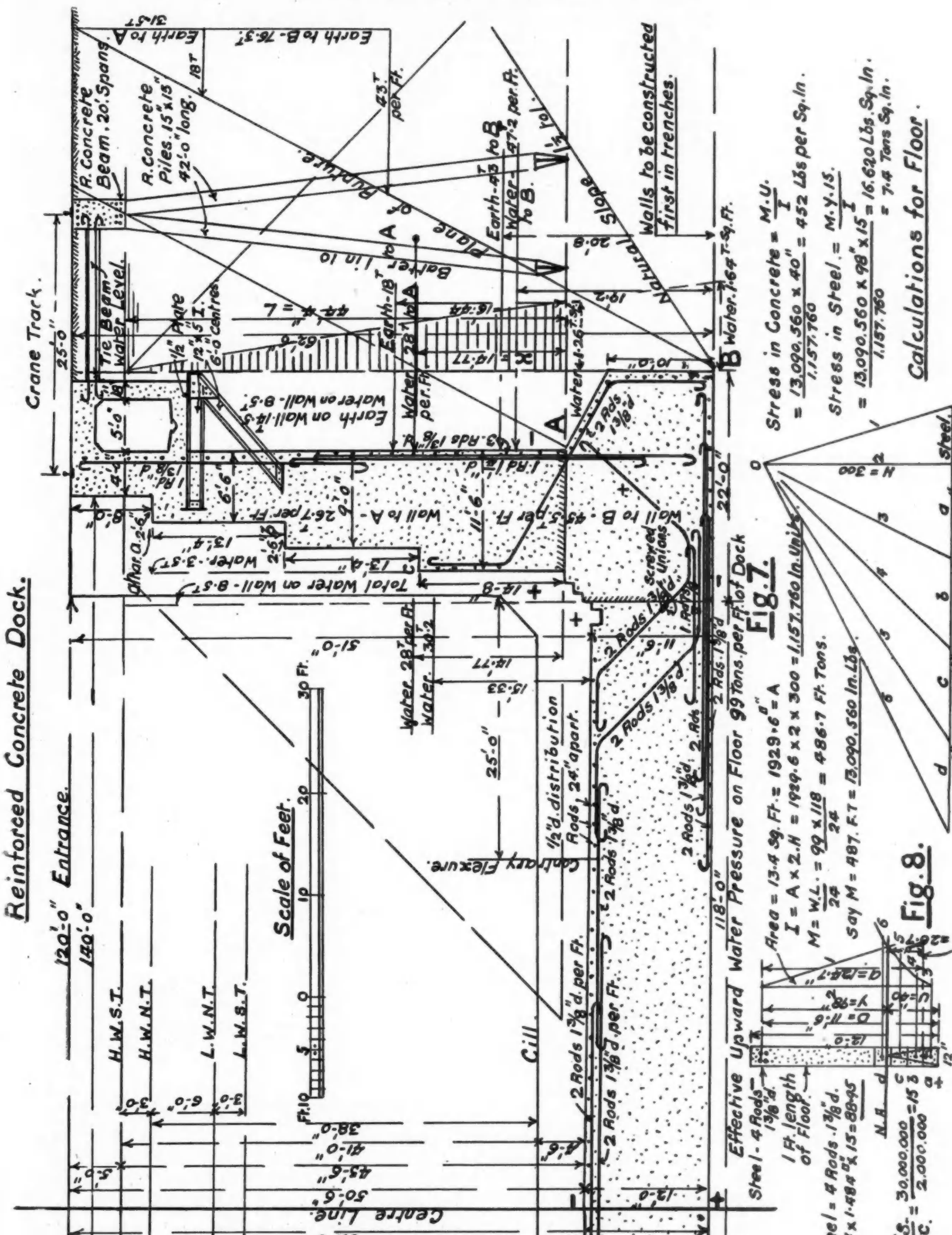
If the dock when reinforced with steel is considered a homogeneous structure, the loads from the floor and walls will be equally distributed over the whole width of 162-ft., resulting in the following weights per sq. ft. on the ground; In Fig. (1)—1.32 tons; (2)—1.42 and (3)—1.63 ton, and excess upward water pressures in Fig. (4) = 0.31 ton; (5) 0.22 and (6) 0.01. ton

The maximum downward pressure on the ground under the floor is 247.8 tons, this occurs in Fig. 2, when the dock is full of water, and there is no upward water pressure; and the greatest upward pressure is 99.1 tons, as in Fig. 4, when the floor is under hydrostatic pressure.

Calculations for Floor

It is assumed that the ground will safely carry the former load which is equal to 2.10 tons sq. ft. or 1.42 tons if equally dis-

Reinforced Concrete Dry Docks—continued



Reinforced Concrete Dry Docks—continued

tributed over the whole width of 162-ft., especially as the maximum load from the walls is 3.10 tons, and the weight of earth to the bases of the walls is 3.44 tons sq. ft.

Therefore, the floor will require to be calculated for an upward pressure of 99 tons per lin. ft. of dock on a span of 118-ft. as there will be no resistance, except the strength of the floor. Fig. 7 is an enlarged half cross section of the dock shown in Figs. 1 to 6, to be reinforced for the load given, the surface of the floor being in tension and the bottom in compression at the centre, and vice versa at the walls for a beam with fixed ends.

The approximate area of steel required at the centre in sq. in. will be $= \dfrac{\text{W.L.}}{24\text{ D.S.}} = \dfrac{99 \times 118\text{-ft.}}{24 \times 11.5 \times 7.5} = 5.64$ sq. inches per lin. ft. of the dock, and 4 steel rods $1\frac{3}{8}$-in. diam. = 1.484 sq. ins. x 4 = 5.93 sq. inches. W = total distributed load in tons, L = span of beam in ft., D = effective depth of beam from steel to edge of concrete in compression, S = safe stress on steel in tons per sq. inch.

If the lever arm, "a" from the C.G. of the concrete in compression = 124.7 inches is taken in lieu of D = 138 inches, the area of steel required will be 6.24 sq. inches.

At the junction of the floor with the walls the area of steel necessary will be $= \dfrac{\text{W.L.}}{12\text{ D.S.}} = \dfrac{99 \times 118\text{-ft.}}{12 \times 10 \times 7.5} = 12.9$ sq. inches.

And 9 rods $1\frac{3}{8}$-in. diam. = 13.35 sq. inches per lin. ft. of dock, will be required at the bottom of the floor.

To find the lever arm "a" and to obtain the stresses in the steel rods, and the concrete in compression, the neutral axis of the beam must be found; this can be done graphically as shown in the diagrams Fig. 8, or calculated by the formula $Z = \dfrac{\text{m.C.}}{\text{S} + \text{m.C.}}$ in which Z is the proportion that the position of the neutral axis bears to the effective depth D of the beam from the compression side, C = safe stress per sq. inch on the concrete in compression, S = safe stress per sq. inch on the steel, $m = \dfrac{\text{E.S.}}{\text{E.C.}}$

The modulus of elasticity of the steel (E.S.) is usually taken at 30,000,000 lbs. per sq. inch, and that of the concrete at 2,000,000 lbs. per sq. inch, there $m = \dfrac{\text{E.S.}}{\text{E.C.}} = 15$.

These moduli vary considerably, especially in the concrete, according to the proportions of the mixture, and its age. For instance,—in a mixture of 1—2—4 broken stone concrete 9 days old, E.C. was 1,667,000; at 3 months old, it was 3,461,000, and in 6 months so much as 4,500,000. A mixture of 1—1.83—3.66 gravel concrete, 28 days old gave E.C. = 3,106,000 to 3,900,000.

Concrete consisting of 1 part of cement, to 1.95 of sand, and 3.9 of quartzite, when 28 days' old gave E.C. = 2,400,000 to 3,300,000, while 1—2—4 trap rock or basalt concrete, 5 months old had a modulus of 4,320,000 lbs. per sq. inch.

The modulus of elasticity of mild steel rods (E.S.) ranges from 27,000,000 to 42,000,000 lb. per sq. inch, so it is possible for the ratio (m) to vary between 7 and 21 in lieu of 15; the lower it is, the nearer will the neutral axis be to the compression side of a beam, the stress in the concrete will be increased, and that in the steel reduced, and vice versa. Reinforced concrete beams usually fail when the elastic limit of the steel is reached, this varies between 35,000 lbs. (15.6 tons) to 45,000 lbs. (20 tons) per sq. inch.

The safe compression to be allowed for large masses of concrete should be limited to about 500 lbs. per sq. inch (although 650 to 750 lbs. per sq. in. may be safely taken for floors and their beams), because of the rougher methods of mixing and depositing the concrete in the former case, the larger sizes of the aggregate, and the longer time required for setting.

In the graphic calculations shown in Fig. 8, Z = 0.29, D = 0.29 x 138-in. = 40-in., which is the distance (U) from the neutral axis to the compression side at the bottom of the floor beam, one foot width being assumed, and the distance (Y) from the neutral axis to the steel = D—U = 138-in.—40-in. = 98-in. these are the lever arms.

By calculation $Z = \dfrac{15 \times 500}{16{,}800 + 15 \times 500} = 0.3$, for rectangular beams with single tensile reinforcement.

The stresses by the graphic method are 452 lbs. per sq. in. for the concrete, and 16,620 lbs. per sq. in. for the steel. If the lever arm (x) from the C.G. of the concrete in compression to the neutral axis = 26.7 ins. is taken in lieu of (U) the average stress in the concrete will be 300 lbs. per sq. in. If the compression area of the concrete is triangular, the C.G. will be $\frac{1}{3}$ U from the base, and if a parabola, which is more accurate, it will be 0.4. U.

The shear on the floor at the walls $= \dfrac{99}{2} = 49.5$ tons, and the safe shear on the concrete at 5 tons per sq. ft. (80 lbs. per sq. inch) = 10.3-ft. x 1-ft. x 5 = 52.5 tons.

To provide additional strength against shear, two inclined rods $1\frac{3}{8}$-in. diam at 45° are inserted in Fig. 7, the safe stress on these = 1.484 sq. in. x 2 x 0.7 x 5 tons = 10.38 tons. Longitudinal rods $\frac{1}{2}$-in. diam. and 2-ft. apart will be required to distribute the stresses.

Calculations for Walls

With regard to the lateral earth and water pressures on the backs of the walls, when the dock is empty, these are shown in the diagram Fig. 7. The walls will weigh about 45 tons each, for a height of 62-ft. 6-in. per lin. ft. of dock, the water pressure is 47.2 tons, and the earth pressure 43 tons, while the upward water pressure is 36 tons under each wall. These need not be considered, as the wall above the floor level at A, Fig. 7, weighing 26.7 tons per ft. will be treated as a cantilever under a triangular load.

The lateral earth pressure per lin. ft. above A = 18 tons and the leverage = 16.44 ft.; the water pressure is 28 tons with a leverage of 14.77 ft., so the maximum bending moment will be due to the water = 28 x 14.77 = 413.56, say 414 ft. tons, or the

$$\text{B.M.} = \frac{\text{P.L.}}{2} \times \frac{\text{L}}{3} = \frac{1.26 \times 44.33}{2} \times \frac{44.33}{3} = 412.37 \text{ ft. tons.}$$

Where P = the water pressure at A in tons per sq. ft. L = total height in feet on which pressure acts.

The area of steel required $= \dfrac{\text{M}}{\text{a} \times 16{,}800}$, and taking M = 414 ft. tons = 11,128,320 inch lbs., therefore $\dfrac{11{,}128{,}300}{118.7 \times 16{,}800} = 5.58$ sq. ins., or if D = 132 ins. is taken in lieu of a = 118.7 ins. the steel area will be 5.5 sq. ins. per lin. ft. of wall, this of course will be reduced in the upper portion of the wall.

Z = 0.3 and U = 0.3 x 132-in. = 39.6-in., say 40-in. and Y = 92-in. The maximum stress in the concrete $= \dfrac{\text{M.U.}}{\text{I}} = \dfrac{11{,}128{,}320 \times 40}{864{,}000} = 515$ lbs. per sq. in. and in the steel $= \dfrac{\text{M.Y M}}{\text{I}} = \dfrac{11{,}128{,}320 \times 92 \times 15}{864{,}000} = 17{,}762$ lbs. per sq. in. (7.92 tons sq. in.).

Therefore 3 rods $1\frac{3}{8}$-in. diam. and 1 rod $1\frac{1}{4}$-in. diam. totalling 5.67 sq. inches will be sufficient. The shear at A is 28 tons, and the safe shear of the concrete = 11.5-ft. x 1-ft. x 5 tons = 57.5 tons per lin. ft. of wall. The total amount of reinforcing steel required for the dock is about 3.71 tons per lin. ft. and in addition the steel brackets and plates supporting the subways will weigh 6 cwts. per lin. ft. including both sides of the dock.

Reinforced Concrete Dry Docks—continued

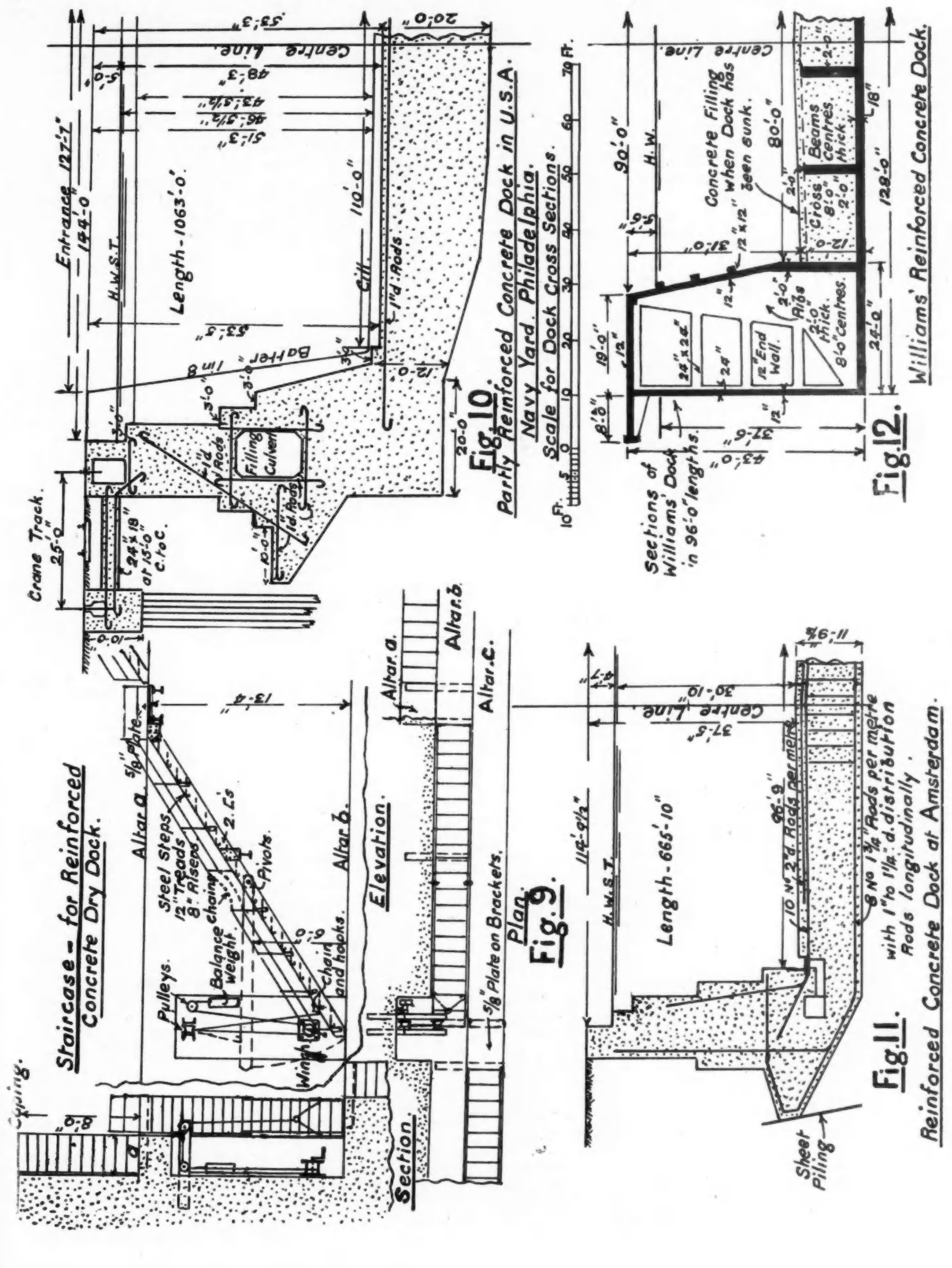


Fig. 10. Partly Reinforced Concrete Dock in U.S.A. Navy Yard, Philadelphia.

Fig. 12. Williams' Reinforced Concrete Dock.

Fig. 9. Staircase—for Reinforced Concrete Dry Dock.

Fig. 11. Reinforced Concrete Dock at Amsterdam.

Reinforced Concrete Dry Docks—continued

Construction of Dock

The amount of scaffolding, timbering of trenches, and shuttering required for mass concrete and reinforced concrete docks is practically the same.

In reinforced docks the walls may be constructed first in trenches, in which case the steel rods will require to have screwed unions at the junctions of the walls with the floor.

If sections of the floor are first constructed then the whole width of the bottom, and the bases of the walls up to level A (Fig. 7) for 162-ft. width should be built; this will avoid screwed unions to the rods. The ½-in. diam. distribution rods should be in 25 to 30-ft. lengths, according to the width of the floor trenches.

The subways for pipes and electric cables shown in Fig. 7 are supported on steel joist brackets to avoid a mass concrete overhang, which is difficult to support unless the filling at the backs of the walls is completed rapidly, there is also the danger of hidden cracks forming in such overhangs, caused by settlement and contraction.

Staircases in Docks

With regard to the stairways in dry dock walls, leading from the coping to the floor; formerly when timber slides were used, pits were formed on each side of the dock, inside the entrance, in the middle of the length, and near the head, with inclined slides from the bottoms of the pits to the floor level.

In some cases the steps were constructed on each side of the slides, and in others, the steps were in the centres of the slides, while some had slides with steps on one side, or with separate steps and slides alternately, they all passed through tunnels in the walls. In modern docks the amount of timber required is practically limited to the spars or struts between the upper altars and the ship to keep her in position in alignment over the keel blocks while the water in the dock is being pumped out.

Formerly when the keels and bilges of vessels were curved, more timber props were required to support the bilges, but with modern ships of almost square cross sections amidships, timber props are no longer necessary, and timber slides are dispensed with, as any required on the dock floor can be lowered by cranes. The pits formed a serious obstruction to the free passage of crane roads and railways, and were a danger to men working in the vicinity of the dock walls; so in modern docks the steps have been formed diagonally down the faces of the walls from altar to altar, and when there are numerous altars, they are placed parallel to them, this causes a steep stairway, which is objectionable. The arrangement of the steps which should be at least 2-ft. 6-in. wide, with 12-in. treads, and risers not more than 9-in., depends upon the number and width of the altars, which should not be less than 2-ft. 6-in. wide except near the floor level.

Fig. 9 illustrates a method of forming the steps entirely in steelwork which may be galvanised; the lower portions of the steps are hinged, and can be raised to allow a free passage along the whole length of the altars. The hinged portions being operated from a wall winch, with counterbalance weight, fixed in a recess in the wall.

Types of Reinforced Concrete Docks

Fig. 10 shows a half cross section of a dry dock in the U.S.A. Naval Yard at Philadelphia, which is partly reinforced in the floor by 1 inch diam. steel rods, laid near the surface from wall to wall, there are also 1 inch diam. steel rods in the walls and round the culvert. The projections of the concrete at the backs of the walls is to counteract the tendency to floatation under hydrostatic pressure from below, as they support masses of earth.

The dock is 1063-ft. long and is divided into two sections by a caisson. The floor is 110-ft. wide, 20-ft. thick at the centre and 12-ft. at the walls.

Fig. 11, is a half cross section of a reinforced concrete dry dock at Amsterdam that was constructed about 1924, it is 665-ft. 10-in. long x 114-ft. 9-in. wide at coping level and 37-ft. 5-in. deep to floor level. The floor is reinforced transversely with 10 steel rods 2-in. diam. per metre near the surface, and with 8 rods 1¾-in. diam. per metre near the bottom, the top and bottom rods being connected with vertical shear stirrups at the centre.

The walls are also reinforced near the front and back with 1-in. diam. steel rods, and the longitudinal distribution rods are 1-in. to 1¼-in. diam.

The width of the floor is about 96-ft. 9-in., and it is 11-ft. 9½-in. thick at the centre.

Fig. 12 illustrates a half cross section of Williams' proposed reinforced concrete dry dock; the width at coping level of this particular one is 90-ft., and 80-ft. at the floor, the depth from coping to floor is 31-ft. and the floor is 12-ft. thick.

It is intended to be constructed on a slipway or in a dry dock in sections each 96-ft. long, which are then launched and towed to the site for the dock, where they are sunk in a previously dredged or excavated area.

The weight of each section 96-ft. long is about 5937 tons, or 61.8 tons per lin. ft. allowing for concrete at 15 cub. ft. per ton, and it will float with a draught of 37-ft. 6-in., giving 5-ft. 6-in. freeboard.

The bottom of the floor consists of reinforced concrete 18 inches thick, with 9-ft. deep cross ribs above it, 2-ft. thick, and 8-ft. apart, centres, also 4 longitudinal ribs 2-ft. thick, forming cells. The walls are formed of two skins of reinforced concrete each 12-in. thick, spaced 24-ft. apart at the floor level and tapering to 19-ft. at coping; with 2-ft. square horizontal struts between the inner and outer walls, spaced 8-ft. apart centres longitudinally; the inner wall skin is further strengthened by 2-ft. thick concrete ribs at 8-ft. intervals.

When the required number of sections of the dock have been sunk in alignment, by partly filling the floor cells with concrete; a dam will require to be constructed outside the entrance, the water inside is then pumped out, and the floor cells and the spaces between the dock sections are filled with concrete, then the 18 inches thick concrete floor is laid. and the entrance, head wall, and stairways completed.

If the site is excavated in the dry, the dock may be built continuously in situ, this would be a less expensive method. The weight of the dock when completed with floor filled with concrete, but with no filling in the hollow walls, is about 101.8 tons per lin. ft. and the uplift under 37-ft. 6-in. head of water pressure is 151.4 tons, so there will be an excess uplift of 49.6 tons per lin. ft.

Allowing for suction below the floor of 1 cwt. per sq. ft. and earth friction against the walls of 6 cwts. per sq. ft., these will amount to 32.2 tons, so there will still be 17.4 tons per ft. in favour of uplift; this can be overcome by partially filling the hollow walls with concrete, through manholes in the deck at coping level.

The Port of Aquaba

The recent signing of the Trans-Jordan-Turkish treaty of friendship with a trade agreement also being negotiated, draws attention to the importance of Trans-Jordan's one outlet to the sea—the Port of Aquaba, on the gulf of the same name. During the last war, with the threat to the Suez Canal and the Allied position in the Near East, a new lighter basin was constructed at Aquaba and also a macadamised road leading to the railway about 50 miles away. As a result of these works, the capacity of the port has been considerably increased, and there can be little doubt that one day Aquaba will be properly developed and exploited. From many points of view it is the most important place in Trans-Jordan, though it has a population of only a few hundred people. Situated near the frontiers of Sinai-Palestine, Palestine-Trans-Jordan, and Trans-Jordan-Saudi Arabia, it commands routes alternative to that of the Suez Canal, and may one day provide a port for traffic between the Near East and India, Australia and the Far East.